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USSR Report

SPACE

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MANNED MISSION HIGHLIGHTS

COSMONAUTS DEPLOY GIRDER FROM 'SALYUT-7'

Moscow PRAVDA in Russian 29 May 86 p 1

[TASS Report]

[Text] Flight Control Center, 28 May--In line with the flight program of the orbiting complex "Salyut-7"--"Soyuz T-15"--"Cosmos-1686," cosmonauts Leonid Kizim and Vladimir Solovyev today made an egress into open space that lasted for 3 hours 50 minutes.

The main purpose of the egress was to practice methods of assembling structures of large size in space. A hinged lattice-work girder which was delivered folded-up to the "Salyut-7" station was used as the standard element.

Comrades Kizim and Solovyev began the work in open space at 0943 hours Moscow time.

The cosmonauts installed a fastening platform on the station's adapter module, and on this platform they installed a unit which included the hinged lattice-work girder and a device for unfolding and folding it. At first the girder was unfolded, and then it was returned to its initial state. The crew conducted a televised report and photography during these operations.

On one of the windows of the work compartment, the cosmonauts installed a new instrument which is intended for experiments for perfecting a future system for transmitting telemetry information in the optical band of wavelengths.

In the course of the egress, the crew dismantled cassettes with specimens of biopolymers and various structural materials which had been on the outer surface of the station for a long time, and also an apparatus developed by Soviet and French specialists for gathering meteorite material in space.

In carrying out all the operations in open space on the outer surface of the station, the crew performed accurately and confidently, in total accord with the designated schedule.

The conditions of the health of Leonid Kizim and Vladimir Solovyev is good, and they are feeling well.

The cosmonauts' successful accomplishment of the unique experiment opens up broad possibilities for the creation of complex large structures in near-Earth orbit.

DEVELOPER COMMENTS ON GIRDER DEPLOYMENT EXPERIMENT

Moscow PRAVDA in Russian 29 May 86 pp 1, 6

[Article by A. Tarasov, correspondent at the Flight Control Center]

[Abstract] The article reports on the extra-vehicular activity of cosmonauts Leonid Kizim and Vladimir Solovyev on the "Salyut-7" station on 28 May, and how it was monitored at the Flight Control Center. Exchanges of communications between flight director Valeriy Ryumin and the cosmonauts as they worked with a folding girder are recorded. Also recorded are comments on one of the developers of the girder, V. Lapchinskiy, head of a department of the Institute of Electric Welding imeni Paton in Kiev. He said:

"Today the operation of a mechanism for unfolding and folding up the girder (which is abbreviated URS) is being tested, as well as the principle of erecting such structures in space. We are at the threshold of the era of space construction--various telescope mirrors, gigantic solar panels, hangars and so forth. The length of our girder is still comparatively short. But the mechanism of a girder-assembly aggregate will make it possible, by loading it with more and more folded cassettes, to build a 'mast' a kilometer long and even more. In addition, it is important for us to know how such a hinged lattice-work structure behaves in zero gravity. The possibilities for conducting such an experiment on Earth are understandably limited."

It is noted that the URS resembles a washing machine, and that it weighs 150 kilograms.

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FURTHER COMMENTARY ON COSMONAUTS' GIRDER DEPLOYMENT, SPECIMEN RETRIEVAL

Moscow TRUD in Russian 29 May 86 p 3

[Article by V. Golovachev, correspondent at the Flight Control Center]

[Abstract] The article reports on the work of cosmonauts Leonid Kizim and Vladimir Solovyev outside the "Salyut-7" orbiting station on 28 May.

The first part of the cosmonauts' extra-vehicular activity reportedly involved the retrieval of specimens that had been installed previously on the station's exterior as part of different experiments. One experiment called "Spiral" had the purpose of studying the effects of outer space on cable products and materials. Another experiment called "Istok" was aimed at determining changes in characteristics of threaded connectors such as nuts and bolts in flight. An experiment called "Resurs" involved assessing the effects of the space environment and stresses on structural metal materials. Study of the long-term combined effects of zero gravity and radiation on biopolymers was the purpose of an experiment called "Meduza."

The main task of the E.V.A. was the setting-up of a mechanism to deploy a folded metal lattice-work girder. The cosmonauts first installed a work platform next to the egress hatch. Then they moved a large drum containing the mechanism out of the station and onto the platform. The hinged girder was folded up insude the drum. It is noted that the total weight of the drum is 150 kilograms, and the weight of the girder alone is 20 kilograms. The test was aimed at checking the operation of the unfolding and folding mechanism, and also at checking the rigidity of the extended girder.

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TASS REPORTS 'SOYUZ TM' SEPARATES FROM 'MIR'

Moscow IZVESTIYA in Russian 30 May 86 p 1

[TASS Report]

[Text] Flight Control Center, 29 May--Today at 1323 hours Moscow time, after completing the program of joint flight, the transport ship "Soyuz TM" was separated from the orbiting complex "Mir"--"Progress-26."

In the course of the six-day flight as part of an orbiting complex, proving-out of new onboard systems, aggregates and structural elements of the improved spaceship was conducted. Corrections of the trajectory of movement of the complex were executed with the aid of the spaceship's combined engine unit.

In line with the flight program, the landing of the "Soyuz TM" ship is planned for 30 May.

The orbiting complex "Mir"--"Progress-26" continues to fly in the automatic mode. Its orbit parameters at the present time are: maximum distance from the surface of Earth--353 kilometers; minimum distance from the surface of Earth--335 kilometers; period of revolution--91.2 minutes; inclination--51.6 degrees.

According to telemetry data, the onboard systems of the complex "Mir"--"Progress-26" and of the ship "Soyuz TM" are functioning normally.

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MANNED MISSION HIGHLIGHTS

TASS REPORTS 'SOYUZ TM' RETURNED TO EARTH

Moscow PRAVDA in Russian 31 May 86 pp 1, 2

[TASS Report]

[Text] Flight Control Center, 30 May--Tests of the improved transport ship "Soyuz TM" have been successfully completed. It is intended for delivering crews to multipurpose manned complexes of the modular type.

Today following checks of the functioning of the ship's onboard systems in independent flight, its engine unit was fired to brake the ship. Then at the calculated time, the reentry vehicle separated from the instrument-and-equipment compartment; it went into a descent trajectory and made a soft landing in the designated area of the territory of the Soviet Union.

The program of testing of the improved transport ship "Soyuz TM," which was placed into near-Earth orbit on 21 May 1986, was fulfilled in its entirety. The creation of a ship of a new series with improved technical and operational characteristics represents the next stage of the development of Soviet manned transport systems.

Cosmonauts Leonid Kizim and Vladimir Solovyev are continuing planned work on board the scientific research complex "Salyut-7"--"Soyuz T-15"--"Cosmos-1686." The condition of the health of the crew is good, and they are feeling well. The flight is proceeding normally.

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COSMONAUTS CONTINUE GIRDER EXPERIMENTS IN SECOND EVA

Moscow PRAVDA in Russian 1 Jun 86 pp 1, 4

[TASS Report]

[Text] Flight Control Center, 31 May--Today cosmonauts Leonid Kizim and Vladimir Solovyev carried out a second phase of work in open space.

The main tasks of the egress into space were to continue tests of the hinged lattice-work girder that were begun on 28 May, and to conduct scientific-technical and technological experiments.

At 0857 hours Moscow time, the cosmonauts opened the outer hatch of the station's adapter module and moved the necessary equipment, instruments and tools to the area where they were to work.

The cosmonauts extended the girder to a length of 12 meters, and with the aid of instruments mounted on it, they conducted an experiment to evaluate dynamic characteristics of its structure. At the same time, studies were made of the atmosphere surrounding the orbiting complex. Transmission of telemetry information from the instruments was accomplished by means of optico-electronic apparatus which had been installed on a window of the work compartment during the preceding egress.

Having completed the scheduled tests and experiments, the cosmonauts returned the girder to its initial position and dismantled it. Then on the outer surface of the station Leonid Kizim and Vladimir Solovyev installed apparatus intended for the study of effects of factors of open space on specimens of structural materials that come under repeated loads.

The next phase of the crew's work in open space involved technological operations with the welding and soldering of elements of girder structures using a portable, improved electron-beam unit.

After completing all of the planned work, the crew commander and the flight engineer returned to the station. The time that they spent outside the station was 5 hours.

Leonid Kizim and Vladimir Solovyev, for the first time in the practice of manned flights, have made eight walks in open space, spending a total of 31 hours and 40 minutes working on the outer surface of the station.

The condition of the health of comrades Kizim and Solovyev is good, and they are feeling well.

The successful accomplishment of multifaceted experimental operations in open space confirms the prospects of the technological operations that have been developed, as well as the possibility of their practical application in creating complex, large-size orbiting complexes for scientific and economic purposes.

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COMMENTARY ON EXPERIMENTS IN SECOND GIRDER DEPLOYMENT

Moscow PRAVDA in Russian 1 Jun 86 p 6

[Article by A. Tarasov, correspondent at the Flight Control Center]

[Abstract] The article records comments of specialists at the Flight Control Center as cosmonauts Leonid Kizim and Vladimir Solovyev performed experiments during their second space walk of the current mission on the "Salyuz-7" orbiting station.

With the folding girder extended to its length of 12 meters, the cosmonauts were performing an experiment called "Mayak" (beacon). A small orange light shone on the end of the girder, and a TV camera was fixed on it to keep track of the girder's movements. Kizim crawled half way up the girder at one point. Candidate of Chemical Sciences G. Zhukov related the following about this experiment:

"If you talk about vibrations, the light will show only the 'rough' ones, which are visible to the eye, amounting to several centimeters, I'd say. It is also important for us to have precise measurements of the rigidity characteristics of the structure, and of various kinds of bending and vibrations of its elements, from apparent ones to ones that almost cannot be recorded. For this, there is a seismic receiver on board, a recorder of small movements that was developed by specialists of the All-Union Scientific Research Institute of Geophysics. Right now, 'lower' vibrations are being recorded simultaneously, that is, those which the station imparts to the girder by its residual velocities. And also 'upper' ones, on the [work] platform. A graph of the vibrations is being received continuously on Earth. It will serve for the creation of a real mathematical model. Beyond that will come development of promising structures for future space construction platforms. For one to comprehend the complexity of this work, let me stress that a tremendous amount of data must be analyzed. Complete processing of the material will take approximately half a year of work using a computer."

The girder reportedly was also being used for an experiment to study the atmosphere around the "Salyut-7" station. Ye. Guzhva, head of a laboratory of the Leningrad Polytechnical Institute, related that this experiment, which is called "Fon" (background), for the first time is using a universal wide-band recorder of the density of rarefied atmosphere. This instrument, which weighs 3 kilograms, is said to be highly reliable and extraordinarily

sensitive: it can distinguish a molecule that has escaped from the upper layers of Earth's atmosphere from one that has its origins in the vicinity of the station. The instrument is called a magnetic discharge converter.

A. Davidenko, head of a sector of the Kharkov Polytechnical Institute, commented on a deformation device which has been installed on the outside work platform and will remain there. It is described as a small tensile-stress machine for testing specimens of materials, namely an aluminum-magnesium alloy. Changes in the specimens to the point of creep are measured.

For sending the data of these various devices from the outside to the inside of the station, scientists under the direction of Professor B. Batalov developed an onboard optical communications system (BOSS). One of the scientists, V. Lartsev, explained that the BOSS has three small units that can convert any type of information from electric pulses into laser pulses and transmit it through window glass, and then reconvert the form of the data for transmission to Earth. The system reportedly uses a 3-milliwatt semiconductor laser with a frequency of one million pulses per second.

It is noted in conclusion that the cosmonauts did welding experiments with the same hand-welding tool that was used by Svetlana Savitskaya and Vladimir Dzhanibekov.

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FEATURES OF 'BOSS' LASER DATA SYSTEM IN 'MAYAK' EXPERIMENT

Moscow TRUD in Russian 1 Jun 86 p 2

[Article by V. Lartsev, designer]

[Excerpt] What will future space complexes be like? They will be made up of what the scientific literature calls large-size structures.

These structures will be assembled from metal girders. It has been evident for a long time that such structures will have to be assembled in orbit.

The best solution is to deliver girders that are folded accordion-fashion, and then 'stretch them out'--unfold them into long structures. The hinged lattice-work girder with which Leonid Kizim and Vladimir Solovyev are working on the "Salyut-7" station will make it possible to solve this problem. This metal structure, which is built in the form of small, interconnected lattice-work cubes, rises upward as it straightens out. Its hinge joints can then be firmly locked by welding them. If about 20 such girders are joined together by welding, a solid structure can be built in orbit. This is one way of creating a station in space without using complex welding equipment for assembling. Yesterday, L. Kizim and V. Solovyev welded together separate structural elements, which were separate from the girder.

L. Kizim and V. Solovyev checked the operational fitness of structural elements and experimentally determined dynamic characteristics of both the girder structure itself, and of the elements which connect the girder's unfolding and folding mechanism (URS) to "Salyut-7."

Numerous sensing devices and instruments are mounted on the whole structure of the girder. Studies are being made of both the girder's vibrations and of the rarefied atmosphere surrounding the orbiting complex (the experiment "Fon," which was performed yesterday). The stream of information from all of these sensors and instruments is very dense. This raised the problem of how to keep the number of wires transmitting information from the sensors from becoming excessive.

A group of young scientists under the direction of Professor B.V. Batalov managed to solve these complex problems on a very tight schedule. They developed an onboard optical communications systems, the acronym of which is BOSS.

The developers first had to select the best means of transmitting information to the inside of the station. Two versions were proposed, one employing a radio channel, the other an optical tract. The radio channel version had to be abandoned in the course of the work--its use would interfere with the operation of various systems of the orbiting complex.

Designing of the main version, the optical one, began after 2 months of experiments.

The transmitting unit of the BOSS is installed on the outer surface of the station, opposite a window. Signals from the scientific instrument-complex are received by this unit, converted into digital form and coded according to a certain algorithm. After this is done, a flow of the most diverse data can be transmitted through a single 'channel.' The role of such a channel is performed by the beam of a low-power laser installed in the transmitting unit. The brightness of the laser beam changes in accordance with the kind of information transmitted through it. The laser beam passes through the glass of the window and strikes the BOSS' receiving unit, which is located inside the station. There light pulses are converted into electric signals, which are directed to a television transmitter after they are processed. They are transmitted from there in digital form to Earth.

Digital representation of transmitted information is a key feature of the system. It minimizes the effects of interference and distortion, since transmission is done in binary code.

Problems of reliability were solved (triple redundancy of main assemblies) in the process of developing the BOSS, as well as problems of temperature conditions and the radiation protection of microcircuits. The BOSS' control system was simplified to the maximum.

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MANNED MISSION HIGHLIGHTS

COSMONAUTS CONTINUE RESEARCH ABOARD 'SALYUT-7'

Moscow KRASNAYA ZVEZDA in Russian 7 Jun 86 p 1

[TASS Report]

[Text] Flight Control Center, 6 June--Leonid Kizim and Vladimir Solovyev, after completing operations connected with the two walks in open space, have continued doing scientific-technical studies and experiments on board the orbiting station "Salyut-7."

The crew has performed a large volume of geophysical studies, which have included visual observations, photography and spectrometry of the Earth's surface, and also study of the structure of the atmosphere and determination of its optical characteristics.

With the aid of instruments mounted on the outer surface of the station, experiments have been conducted for determining the effects of factors of open space on specimens of structural materials that are subject to periodic stresses.

Experiments with lettuce seeds have begun in the "Biogravistat" unit for studying the effects of artificial gravity on the development of higher plants in conditions of space flight.

The cosmonauts have prepared apparatus for work which is intended for measuring flows of high-energy electrons and positrons, for the purpose of studying mechanisms of the generation of these particles in near-Earth space.

Another series of geophysical studies is planned for today. In line with its program, an experiment also will be performed for determining the density of aerosol layers of cosmic origin in the Earth's atmosphere.

According to the crew's reports and telemetry data, the flight of the manned complex "Salyut-7"--"Soyuz T-15"--"Cosmos-1686" is proceeding normally.

The condition of the health of Leonid Kizim and Vladimir Solovyev is good, and they are feeling well.

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'MARIYA,' 'SPORT' EXPERIMENTS PERFORMED

Moscow IZVESTIYA in Russian 11 Jun 86 p 1

[TASS Report]

[Text] Flight Control Center, 10 June--The prolonged orbital flight of Soviet cosmonauts Leonid Kizim and Vladimir Solovyev is continuing.

The crew's work program during the days just passed included astrophysical and geophysical studies and biological experiments.

A series of measurements of high-energy electrons and positrons was made with the aid of the "Mariya" apparatus, for the purpose of studying mechanisms of the generation of these particles in near-Earth space.

Astrophysical experiments using the magnetic spectrometer "Mariya" will be continued today.

Also planned are geophysical studies which call for visual observations and photographing of individual areas of land surface and the waters of the world's oceans, and for determining spectral and optical characteristics of the Earth's atmosphere.

Physical exercise is essential in conditions of prolonged space flight. The cosmonauts performed an experiment called "Sport" in the morning, for the purpose of selecting optimal conditioning regimens.

According to results of telemetry and reports from orbit, the flight of the scientific research complex "Salyut-7"--Soyuz T-15"--"Cosmos-1686" is proceeding normally.

The condition of the health of Leonid Kizim and Vladimir Solovyev is good, and they are feeling well.

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MANNED MISSION HIGHLIGHTS

KIZIM AND SOLOVYEV PASS THREE MONTH MARK IN ORBIT

Moscow PRAVDA in Russian 14 Jun 86 p 1

[TASS Report]

[Text] Flight Control Center, 13 June--Leonid Kizim and Vladimir Solovyev have completed their third month of work in near-Earth orbit.

On board the scientific research complex "Salyut-7"--"Soyuz T-15"--"Cosmos--1686," they have performed astrophysical and geophysical studies, biological and technical experiments, and medical monitoring examinations.

In line with the program of research of Earth natural resources and study of the environment, the crew has conducted several series of picture-taking of various stationary cameras and spectrometry apparatus.

Today a large part of the cosmonauts' working time is reserved for geophysical experiments. The regions that have been chosen for picture-taking are the Ukraine, Krasnodar Kray, Stavropol Kray, the republics of the Caucasus region, and waters of the Black and Caspian seas.

Also planned are two hours of physical conditioning on the exercise bicycle and the running track.

According to the conclusion of physicians of the medical support group, Leonid Kizim and Vladimir Solovyev are maintaining high working fitness and good health after 3 months of orbital flight.

The work on the "Salyut-7" station is proceeding in line with the designated mission program.

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COSMONAUTS CONTINUE MATERIALS, BIOCHEMICAL STUDIES

Moscow IZVESTIYA in Russian 18 Jun 86 p 1

[TASS Report]

[Text] Flight Control Center, 17 June--Leonid Kizim and Vladimir Solovyev are continuing planned work on board the scientific research complex "Salyut-7"--"Soyuz T-15"--"Cosmos-1686."

During the days just past, the crew performed experiments for studying the Earth's surface and atmosphere, as well as biological and medical studies. Work was done with an apparatus called "Kristallizator," which was manufactured by specialists of Czechoslovakia and is intended for studying processes of mass and heat transfer and of crystallization of various materials in conditions of extremely low gravitation.

The cosmonauts performed a number of biochemical experiments this morning. The purpose of this work is to study the mechanism of regulation of water-salt metabolism and features of hydrocarbon metabolism in a human organism which is in zero gravity for a prolonged period of time.

Studies of characteristics of the Earth's atmosphere will be continued in the course of the day, and experiments are planned for further study of the spatial distribution of high-energy electrons and positrons in near-Earth space. Technical experiments are planned.

According to reports from orbit and telemetry data, the flight of the manned complex is proceeding normally.

Leonid Kizim and Vladimir Solovyev are healthy. They are feeling well.

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EXPERIMENTS CONTINUE ON 'MIR,' ORBIT OF 'SALYUT-7' BOOSTED

Moscow PRAVDA in Russian 21 Jun 86 p 2

[TASS Report]

[Text] Flight Control Center, 20 June--Leonid Kizim and Vladimir Solovyev have been working in near-Earth orbit for 100 days.

In the past days on board the scientific research complex "Salyut-7"--"Soyuz T-15"--"Cosmos-1686" they have carried out more series of experiments in geophysics and astrophysics, as well as medical monitoring examinations, technical experiments, and preventive maintenance work on equipment of the station.

In line with the program of biological studies, experiments have been completed in the "Oazis," "Biogravistat" and "Svetoblok" units.

Today's program of work includes astrophysical and technical experiments, and two hours of physical exercise on the stationary bicycle and the running track.

Preventive maintenance work on the station's temperature-control system is planned. The cosmonauts will replace individual assemblies whose service life is running out.

In line with the flight program of the orbiting complex "Mir"--"Progress-26," a correction of its trajectory of movement has been executed using the engine unit of the cargo ship. On the day before this, the station's fuel tanks were filled up with fuel from tanks of the "Progress-26" ship. Refueling with a second component--oxidizer--is planned for today.

Work on board the manned complex "Salyut-7"--"Soyuz T-15"--"Cosmos-1686" and the flight of the orbiting complex "Mir"--"Progress-26" are proceeding normally.

Cosmonauts Leonid Kizim and Vladimir Solovyev are in good health, and they are feeling well.

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'PROGRESS-26' UNDOCKED FROM 'MIR,' COSMONAUTS PREPARE TO LEAVE 'SALYUT-7'

Moscow IZVESTIYA in Russian 24 Jun 86 p 1

[TASS Report]

[Text] Flight Control Center, 23 June--After completion of the program of joint flight, the automatic cargo ship "Progress-26" separated from the orbiting station "Mir" on 22 June at 2225 hours Moscow time.

All planned operations--unloading, refueling of the station, pumping of drinking water--were fulfilled during the time of the joint flight. A correction of the trajectory of movement of the orbiting complex was executed with the aid of the engine unit of "Progress-26."

Leonid Kizim and Vladimir Solovyev are completing research and experiments on board the manned complex "Salyut-7"--"Soyuz T-15"--"Cosmos-1686."

In line with the program of further experiments in near-Earth orbit, the cosmonauts plan to return to the "Mir" station, on which they worked between 15 March and 5 May 1986.

Today the crew began deactivating onboard systems and instruments of the "Salyut-7" station and the "Cosmos-1686" satellite. The cosmonauts also are dismantling part of the scientific equipment and are moving it into the "Soyuz T-15" ship.

The separation of the "Soyuz T-15" ship from the scientific research complex "Salyut-7"--"Cosmos-1686" is scheduled for 25 June.

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'PROGRESS-26' DEORBITED, COSMONAUTS CONTINUE PREPARATIONS

Moscow IZVESTIYA in Russian 25 Jun 86 p 1

[TASS Report]

[Text] Flight Control Center, 24 June--The flight of the automatic transport ship "Progress-26," which was launched into near-Earth orbit on 23 April 1986, has ended. On 23 June on commands from the Control Center, the ship was oriented in space, and at 2240 hours Moscow time, its engine was fired. As a result of braking, the "Progress-26" went into a descending trajectory, entered the dense layers of the atmosphere, and ceased to exist.

Leonid Kizim and Vladimir Solovyev are continuing to prepare the orbiting complex "Salyut-7"--"Cosmos-1686" for flight in the automatic mode. Today the cosmonauts are performing operations to deactivate on-board systems and apparatus of the station. The crew is moving containers with materials of completed research and experiments into the "Soyuz T-15" ship, and also part of the station's scientific apparatus, which includes photo cameras, spectrometers, medical instruments and various equipment.

The work in orbit is proceeding in line with the designated program.

The condition of the health of both cosmonauts is good, and they are feeling well.

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COSMONAUTS IN 'SOYUZ T-15' UNDOCK FROM 'SALYUT-7'

Moscow IZVESTIYA in Russian 27 Jun 86 p 3

[TASS Report]

[Text] Flight Control Center, 25 June--Cosmonauts Leonid Kizim and Vladimir Solovyev have completed the program of a 50-day flight on board the scientific station "Salyut-7."

The spaceship "Soyuz T-15" separated from the orbiting complex "Salyut-7"--"Cosmos-1686" today at 1858 hours Moscow time.

In the course of their work on board the station, the cosmonauts regularly photographed various areas of the territory of the Soviet Union and of waters of the world's oceans. Experiments for studying the atmosphere and streams of charged particles in near-Earth space were continued. Also performed were a number of biological and medical studies, and technical and technological experiments. During two egresses into open space, the crew perfected methods for deploying large structures in zero gravity. Operations for welding and soldering standard elements of such structures were performed with the aid of a portable electron-beam unit.

In line with the program of further work in near-Earth space, the cosmonauts are to make a flight over to the orbiting station "Mir." Plans call for docking the manned spaceship "Soyuz T-15" with the "Mir" station on the night of 26-27 June.

According to telemetry information, the onboard systems of the spaceship "Soyuz T-15," the "Mir" station and the orbiting complex "Salyut-7"--"Cosmos-1686" are functioning normally.

The condition of the health of cosmonauts Leonid Kizim and Vladimir Solovyev is good, and they are feeling well.

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BALLISTICS GROUP CHIEF DESCRIBES RENDEZVOUS, DOCKING OF 'SOYUZ T-15' AND 'MIR'

Moscow IZVESTIYA in Russian 27 Jun 86 p 3

[Article by A. Ivakhnov, correspondent]

[Abstract] The article reports on activities in space and at the Flight Control Center as cosmonauts Leonid Kizim and Vladimir Solovyev in the spaceship "Soyuz T-15" separated from the "Salyut-7" station to make a shuttle flight to the other orbiting station, "Mir." The article records the following comments of Vladimir Nikolayevich Pochukayev, the Flight Control Center's ballistics group leader, regarding particulars of the move between orbiting stations:

"You will recall that during the last shuttle flight, the cosmonauts had to catch up to the 'Salyut-7' station. This time it is the 'Mir' that is flying ahead--the stations have changed positions as a result of the difference in their orbits. At present they are about 3,000 kilometers apart, and the 'Mir' is about 25-30 kilometers higher than the 'Salyut-7'--'Cosmos-1686' complex. When the distance between the ['Soyuz T-15'] ship and the 'Mir' closes to 20 kilometers, their radio systems will locate each other, and from that point the ship will be guided automatically to the rendezvous point. When they are 100 meters apart, the station will turn around, with the front docking port on the adapter module pointed at 'Soyuz T-15.' Then the cosmonauts will assume manual control of the ship. Manual control is necessary in the final meters due to the fact that the 'Igla' system, with which the ship will interact, is not located on the docking port of the station where the 'Soyuz T-15' will dock..."

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EQUIPMENT TRANSFERRED FROM 'SALYUT-7' TO 'MIR'

Moscow PRAVDA in Russian 28 Jun 86 p 6

[Article by A. Tarasov, correspondent at the Flight Control Center]

[Abstract] The article reports on the flight of cosmonauts Leonid Kizim and Vladimir Solovyev in the "Soyuz T-15" spaceship between the orbiting station "Salyut-7" and the "Mir" station. Excerpts of communications between the cosmonauts and the Flight Control Center are recorded.

The article identifies a number of items of scientific equipment that the cosmonauts removed from "Salyut-7" and took with them to the "Mir" station. This equipment included the electrophoresis unit "Robot," the ultrasonic cardiograph "Argument," the astrophysical spectral apparatus "PCN," the video complex "Niva," the KATE-140 camera, and the "Pion-M" unit. It is mentioned that this equipment was to be used to carry on the scientific program until scientific modules are sent up to the "Mir" station.

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COMMENTS ON COSMONAUTS' SHUTTLE BETWEEN STATIONS

Moscow TRUD in Russian 28 Jun 86 p 3

[Article by V. Golovachev, special correspondent at the Flight Control Center]

[Abstract] The article records conversations between cosmonauts Leonid Kizim and Vladimir Solovyev and personnel of the Flight Control Center as the cosmonauts were redocking the spaceship "Soyuz T-15" with the orbiting station "Mir," reboarding the station and starting its reactivation.

USSR pilot-cosmonaut V.N. Kubasov and Doctor of Technical Sciences K.P. Feoktistov were at the control center. They and V.D. Blagov, deputy flight director, are quoted as follows regarding work which Kizim and Solovyev did on board the orbiting station "Salyut-7," and the significance of the flights between this station and the "Mir" station.

Kubasov: "I wish to emphasize the great importance of this work: almost all of the flight was made in the automatic mode. The crew took over control only when the spaceship was approximately 50 meters from the station, as was called for by the program. In principle, however, the transport ship's entire flight between the two stations could have been made in the automatic mode. You can imagine how important it will be to have such an automatic ferry for future space complexes. These transport ferries could fly, for example, between residential and industrial zones of a space colony, or between various modules and extraterrestrial observatories. Moreover, a ferry could, if necessary, be sent from one space base to another as a means of rescuing cosmonauts if their spaceship broke down..."

Feoktistov: "These cross-flights are a very complex business. They require precise, well-coordinated work by both ground services and the crew. Take, for instance, the fact that the stations are constantly trying to drift apart or 'scatter' to a distance as great as several thousand kilometers, because of the difference in their velocities. They must be controlled and their movements synchronized skillfully, without excessive consumption of fuel."

Blagov: "This flight was really unique; it was the first time that a crew made a round trip between one station and another. What was left of the previous crew's program was completed on board the 'Salyut-7' station. L. Kizim and V. Solovyev have now removed all of the manual scientific equipment--spectrometers, still and video cameras, tape recorders, etc.--from this station. This equipment weighs about 400 kilograms in all. It will be used on board 'Mir' for conducting scientific research until laboratory modules arrive at the station."

It is mentioned in conclusion that prolonged preservation of "Salyut-7" in orbit has been proposed for the purpose of ascertaining the service life of systems still operating on the station. This could be done by sending a crew to the station at a future date to remove equipment of interest to specialists and delivering it to Earth for analysis.

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KIZIM AND SOLOVYEV PASS 110-DAY MARK IN ORBIT

Moscow IZVESTIYA in Russian 2 Jul 86 p 1

[TASS Report]

[Text] Flight Control Center, 1 July--Leonid Kizim and Vladimir Solovyev have been working in near-Earth orbit for 110 days.

Studies of characteristics of the "Mir" station's temperature control system during operation in conditions of maximum heat were made yesterday, in line with the program of technical experiments.

The next working day of the crew of the orbiting complex "Mir"--"Soyuz T-15" began at 0900 hours and will last until 2400 hours. Biological experiments with the "Svetoblok" unit are included in the program of work, as well as two hours of physical exercise on the stationary bicycle and the running track. In line with the plan for further equipping the station, the cosmonauts will install additional units in the onboard information system "Strela," and they will begin setting up scientific equipment delivered from the "Salyut-7" station.

According to data of trajectory measurements, the orbit parameters of the manned complex "Mir"--"Soyuz T-15" are: maximum distance from the surface of Earth--372 kilometers; minimum distance from the surface of Earth--343 kilometers; period of revolution--91.4 minutes; inclination--51.6 degrees.

During periods of communications, the cosmonauts are reporting that the flight is proceeding normally.

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COSMONAUTS INSTALL EQUIPMENT, CONTINUE RESEARCH PROGRAM

Moscow IZVESTIYA in Russian 5 Jul 86 p 1

[TASS Report]

[Text] Flight Control Center, 4 July--Leonid Kizim and Vladimir Solovyev are continuing their flight on board the orbiting complex "Mir"--"Soyuz T-15."

In the past days the crew has been doing work on outfitting the station with new instruments and equipment, and adjusting and testing individual instruments and units. They have continued experiments in the program for study of Earth natural resources and the environment. The crew photographed regions of ore deposits in the Maritime Territory, geological formations around Dushanbe, glaciers of the Pamir and Tyan-Shan mountain ranges, desert pasturelands in Turkmenia and the Kalmyk ASSR, and the basins of the Caspian and Aral seas.

Today photographing of the country's territory will be continued. Also planned are preventive maintenance work on individual units of the life-support system, and adjusting and testing of onboard instruments.

Results of a comprehensive medical examination show that both cosmonauts have maintained good health and a high level of working fitness throughout the period of prolonged flight. The commander's pulse rate is 59 beats per minute and the flight engineer's is 66, and their blood-pressure readings are 110/60 and 115/65, respectively.

According to the reports from orbit and telemetry data, the flight of the manned complex "Mir"--"Soyuz T-15" is proceeding normally.

FTD/SNAP
/8309
CSO: 1866/16

COSMONAUTS CONTINUE GEOPHYSICAL STUDIES, PHOTOGRAPHY

Moscow PRAVDA in Russian 9 Jul 86 p 1

[TASS Report]

[Text] Flight Control Center, 8 July--Leonid Kizim and Vladimir Solovyev are in their 118th day of work in near-Earth orbit.

A large part of the work today for the crew of the manned complex "Mir"--"Soyuz T-15" involves geophysical experiments of the program for study of Earth natural resources and the environment. The cosmonauts are taking pictures of glaciers of the Pamir and Tyan-Shan mountain ranges, farmlands of Kazakhstan, geological structures in the Southern Ukraine, and lands of the Astrakhan Nature Preserve.

The day's program also includes technical experiments, work on installing additional equipment in the station, and two hours of physical conditioning.

Geophysical experiments will be continued in the upcoming days.

According to telemetry data and the crew's reports, the onboard systems of the "Mir" station are functioning normally. Leonid Kizim and Vladimir Solovyev are healthy and feeling well.

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CSO: 1866/16

COSMONAUTS PERFORM MEDICAL EXAMS, CONTINUE EARTH RESOURCES STUDIES

Moscow IZVESTIYA in Russian 12 Jul 86 p 1

[TASS Report]

[Text] Flight Control Center, 11 July--The crew of the manned complex "Mir"--"Soyuz T-15" is continuing to perform planned work in near-Earth orbit.

The flight program in the past days has included medical studies and geophysical experiments.

Leonid Kizim and Vladimir Solovyev made a comprehensive examination of their cardiovascular systems, and also performed a number of biochemical experiments.

In line with the extensive program of study of Earth natural resources and the environment, the cosmonauts took photographs of the country's East coast, Lake Baykal, the Aral and Caspian seas, glaciers of the Caucasus region, and the Volgograd Reservoir.

Today the crew will perform several more series of picture-taking of various regions of the territory of the Soviet Union using cameras and spectrometers. Geological structures of Sakhalin, volcanoes of Kamchatka, the waters of the Aral and Caspian seas, farmlands of Kazakhstan, and separate shallow sections of the Black Sea have been chosen as objects of study.

According to results of medical monitoring, the condition of the health of Leonid Kizim and Vladimir Solovyev is good, and they are feeling well.

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/8309
CSO: 1866/16

COSMONAUTS CONCLUDE RESEARCH PROGRAM ABOARD 'MIR'

Moscow IZVESTIYA in Russian 15 Jul 86 p 1

[TASS Report]

[Text] Flight Control Center, 14 July--Cosmonauts Leonid Kizim and Vladimir Solovyev are completing research and experiments on board the orbiting complex "Mir"--"Soyuz T-15" and are preparing the station for flight in the automatic mode.

Today the cosmonauts will perform a series of photography of separate regions of the territory of the German Democratic Republic as part of the experiment "Geoeks-86," in line with the program of the large-scale international project "Study of Dynamics of Geosystems by Remote Methods."

The task of this joint experiment, which is being carried out by socialist countries, is to perfect methods of studying the condition of various ecological systems with the aid of aerospace means of remote study of Earth.

The experiment "Geoeks-86" is being conducted on the territory of the GDR. Photography of the Earth's surface from the "Mir" station is being accompanied by simultaneous photography from the artificial Earth satellite "Cosmos-1602" and also from a laboratory airplane.

Results of the experiment will be used for monitoring the condition of forest tracts and farmlands, and for planning measures of environmental protection in member countries of the Council for Mutual Economic Assistance.

Tomorrow the crew will perform the final series of photography in the program of the "Geoeks-86" experiment.

According to reports from orbit and telemetry data, the flight of the orbiting complex "Mir"--"Soyuz T-15" is proceeding normally. Both cosmonauts are feeling well. They will return to Earth on 16 July.

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CSO: 1866/16

TASS REPORTS KIZIM AND SOLOVYEV RETURN TO EARTH IN 'SOYUZ T-15'

Moscow SOVETSKAYA ROSSIYA in Russian 17 Jul 86 p 1

[TASS Report]

[Text] Comrade cosmonauts Leonid Denisovich Kizim and Vladimir Alekseyevich Solovyev successfully completed the program of a 125-day orbital flight and returned to Earth on 16 July 1986, at 1634 hours Moscow time.

The reentry vehicle of the "Soyuz T-15" ship made a landing 55 kilometers northeast of the city of Arkalyk. The cosmonauts were feeling well after the landing.

For the first time in the history of cosmonautics, a crew made interorbital flights between two orbiting complexes and carried out work on them.

Comprehensive tests were made of the structural elements and onboard systems of the new "Mir" station. Its instrumentation was adjusted and tuned, and the station was additionally outfitted with instruments and equipment that were delivered into orbit by two "Progress" automatic cargo ships, and also by the "Soyuz T-15" ship from the orbiting complex "Salyut-7"--"Cosmos-1686." The first stage of work on the "Mir" station was fulfilled in its entirety.

On the "Salyut-7" station, the crew successfully performed a complex of work in open space in the way of perfecting technological operations for the purpose of using them in practice for the creation in the future of large, complex structures in near-Earth orbit. The cosmonauts completed the scientific and technical studies that were called for in the program of operation of this station.

In carrying out the mission program, the crew demonstrated courage and high professional skill.

The "Mir" station and the orbiting complex "Salyut-7"--"Cosmos-1686" are continuing to fly in the automatic mode.

Results of the research and experiments performed in the course of the flight of Leonid Kizim and Vladimir Solovyev will find extensive application in various branches of science and the economy. The experience of organizing the work of a crew on two orbiting stations during a single mission will be utilized in the operation of multi-purpose permanently-operating manned complexes with specialized orbital modules.

The completion of another prolonged mission of Soviet cosmonauts represents a worthy contribution to the implementation of the historic decisions of the 27th Congress of the Communist Party of the Soviet Union regarding the further exploration of space for peaceful purposes.

(A photograph is given showing Kizim and Solovyev in their space suits after their landing.)

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CSO: 1866/16

COMMENTS ON WORK OF COSMONAUTS, POST-FLIGHT CONDITION

Moscow TRUD in Russian 17 Jul 86 p 4

[Article by V. Khrustov, correspondent]

[Abstract] The short article records comments of General-Major of Aviation A. Filipchenko, pilot-cosmonaut of the USSR. Filipchenko had flown to Arkalyk on the day before the landing of "Soyuz T-15" cosmonauts Leonid Kizim and Vladimir Solovyev. He summed up the cosmonauts' work on the "Mir" and "Salyut-7" orbiting stations. After the cosmonauts had landed and undergone an on-the-spot examination by a medical team, Professor L. Stazhadze, head of a department of the Institute of Medical-Biological Problems, reported that they were naturally tired, but that they were feeling pretty well, and there was nothing especially unexpected in their condition. Journalists at the landing site were told that they could talk with the cosmonauts after they had returned to the cosmodrome.

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CSO: 1866/16

COMMENTARY ON COSMONAUT GIRDER DEPLOYMENT

Moscow MOSCOW NEWS in English No 23, 15-22 Jun 86 p 3

[Unsigned article: "Zero Gravity 'Construction Site'"]

[Text] On May 28, Leonid Kizim and Vladimir Solovyov walked out into open space to cover the Salyut-7 with a pin-connected framework unit which may become the prototype for future large structures to be assembled in near-Earth orbits.

"This experiment had several aims," said V. Lapchinsky, department head, E.O. Paton Electric Welding Institute, Ukrainian SSR Academy of Sciences. "The main aim was to test in zero gravity conditions a special device for unfolding and folding the framework unit. It is a cylinder, weighing 150 kg, containing a folded bellows-like framework unit (FWU), made of hinged metal tubes. The FWU can be operated automatically, semiautomatically or manually.

"It may be made rigid by welding, if necessary. Another objective was to test whether a platform with instruments could be fixed at the end of the truss. How will the structure behave in weightlessness? Are we going the right way? The orbital experiment will help us get the answers.

"The crew dismantled the magazines containing biopolymers and various structural materials that had been exposed at the space side of the craft for a long time, and the meteorite matter collecting device, jointly developed by Soviet and French experts. This was Leonid Kizim's and Vladimir Solovyov's seventh space walk, which lasted 3 hours and 50 minutes."

Leonid Kizim and Vladimir Solovyov performed their next, eighth, walk in outer space on May 31. The cosmonauts unfolded a hinged lattice truss 12 m in length and studied the structure's behaviour in the actual conditions of space flight. Simultaneously, they examined the atmosphere near the orbital complex.

The walk lasted five hours.

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CSO: 1852/4

SEMENOV AND PATON ON SIGNIFICANCE OF COSMONAUT GIRDER DEPLOYMENT EXPERIMENT

Moscow PRAVDA in Russian 16 Aug 86 p 3

[Article by B. Paton, academician, and Yu. Semenov, doctor of technical sciences: "Star Construction Projects: 'Salyut-7'-'Mir' -- Our Commentary"]

[Text] Late in 1983 the pages of PRAVDA carried an article by Academician B. Paton and Doctor of Technical Sciences Yu. Semenov in which they discussed the possibilities and prospects for a substantial broadening of work on the use of near space in the interests of the economy. In particular, their article made reference to a future orbital complex based on so-called large-size construction parts.

Today, after the successful implementation of the "Mayak" experiment by L. Kizim and V. Solovyev, these same authors analyze this new step in solution of the formulated problem.

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The assembly of large-size orbital constructions is a qualitatively new, completely necessary and at the same time a technically very complex stage in the mastery of space. In order to solve the problems arising here it is necessary to have more than research conducted on earth. There is also a need for checking specific construction solutions under real orbital flight conditions.

A cycle of such research also was initiated by the "Mayak" experiment, carried out in open space by L. Kizim and V. Solovyev aboard the "Salyut-7" orbital station on 28 and 31 May 1986. The cosmonauts executed a full range of experiments in constructing supporting girder structures. What was the essence of this work?

The special URS girder assembly apparatus was developed and fabricated by the Electrical Welding Institute imeni Ye. O. Paton, Ukrainian Academy of Sciences. Compactly fitted within the apparatus is a jointed-lever girder which can be deployed for a length up to 15 meters. In such a state it is capable of supporting a special platform with a useful load. In the "Mayak" experiment the platform held different instruments which made it possible to register the dynamic parameters of the girder in the process of its deployment, use, and return, and also to study the residual atmosphere surrounding the orbital station. In addition, in case of necessity it is possible to carry out welding or soldering of joint connections. In this case the beam can no longer be

deployed but its rigidity and supporting capacity are considerably increased.

At the same time there was testing of a new modification of the universal working tool known as the URI [universalnyy rabochiy instrument], designed taking into account the comments and recommendations made by S. Savitskaya and V. Dzhanibekov on the basis of experiments carried out aboard this same station in July 1984. The tool has become simpler and is easier to use.

The dynamics of generation and damping of different forms of mechanical oscillations was investigated by means of an on-board television set and BSP seismic detector developed by the All-Union Scientific Research Institute of Geophysics. An optical light-emitting diode communication unit known as the BOSS [blok opticheskoy svetodiodnoy svyazi] was used for the first time for data transmission.

After the demounting of the girder-assembly apparatus, the "Mikrodeformator" apparatus developed at the Kharkov Polytechnic Institute and intended for study of the physicomechanical properties of construction materials during prolonged complex cyclic loadings under open space conditions was mounted on its attachment platform and put into operation. The first results of this experiment, registered by means of the BOSS, were returned to earth.

The crew of the orbital station operated smoothly during implementation of the "Mayak" experiment. Its reproachless and disciplined work merits the highest praise. The additional information received from the space installers L. Kizim and V. Solovyev, their conclusions and recommendations are helping in elaborating plans for conducting new research. But even now it can be asserted that we are on the right path. A serious step has been taken toward the development of multicomponent orbital complexes of the future.

It is now clear that jointed-lever girders can become, for example, the basis for supporting structures for large-size solar cells -- with respect to their area they will be ten times greater than those now in existence. Moreover, the girder assembly apparatus will serve as a prototype for automatic girder construction equipment intended for the space deployment of linear girder constructions with an extent up to several hundreds of meters. In addition, the new URI modification is capable of becoming the working element of a robot welder which will also be assigned the task of space assembly of different kinds of constructions.

Distinct prospects for the "Mikrodeformator" are being examined. It can be called the "forefather" of a whole series of on-board measurement instruments for use in connection with space materials science. Such research will make it possible to construct a mathematical model of the degradation of materials and to make a reliable prediction of their behavior during use for 25 or more years in advance.

But in general all the apparatus used in the "Mayak" experiment must be regarded as an integrated measurement complex and regarded as the prototype of future systems for the operational technical diagnosis of large-size structures in space. In addition to highly sensitive sensors, they will include devices

for the collection, processing and transmission of information, large data banks and devices for the display of information and signaling. Such systems are capable of constantly monitoring the state of all the principal construction elements, detecting damage or local changes in the strength characteristics and giving recommendations on the conducting of repairs.

Thus, the "Mayak" space experiment takes in virtually all the principal aspects of technological and materials science support of construction and operation of large-size structures. The success of the experiment gives a basis for speaking of the next logical stage: organization on the "Mir" orbital station of a construction platform, a test platform for the further development and improvement, under flight conditions, of the technological processes of installation and servicing of large-size, full-scale construction parts having different functions, geometry and dimensions.

At the same time, it is already necessary to think of the planned transition from scientific research and experimental checking to the practical use of the accumulated experience. To be sure, this will require the use of new construction materials, investigation of fundamentally new approaches to strength computations and the designing of a variety of mechanisms, including multifunctional space robots. In essence, it is necessary to develop a new direction in technology -- space machine building, oriented on the production of the machines and mechanisms required for broad-scale construction in space. It is also necessary to develop programs for the specialized preparation of crews for future orbital stations -- multicomponent complexes growing in space and developing with time.

It goes without saying that all this is a matter of the future. But the launching of the first module of the "Mir" station and the successful implementation of the "Mayak" experiment also convincingly indicate that a new stage in the mastery of space, related to the construction of large-size structures, has become a reality in our day.

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CSO: 1866/1

SEMENOV COMMENTARY ON ACHIEVEMENTS OF 'SALYUT-7', NEW PLANS FOR STATION

Moscow PRAVDA in Russian 8 Sep 86 p 7

[Article by Yu. Semenov, doctor of technical sciences, director of plans for development of manned space vehicles for international programs: "800 Days of Watch. 'Salyut-7' -- Our Commentary"]

[Text] As already reported, the work program for the cosmonauts aboard the "Salyut-7" station has been completed. In June 1986, with the departure of the cosmonauts Leonid Kizim and Vladimir Solovyev, work was finished under the manned program of the "Salyut-7" station, ending a series of long-term orbital stations of the "Salyut" type, which over the course of 15 years have kept their space watch in the interests of science and the economy.

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The "Salyut-7" station has been in a circumterrestrial orbit since April 1982. Ten crews have worked aboard it, including two international crews with the participation of citizens of France and India. Fifteen cargo craft have carried supplies to the station.

The total time of flight of the "Salyut-7" station with cosmonauts aboard was more than 800 days, and in the course of its operation there was a 237-day expedition, the longest in the history of cosmonautics. Svetlana Savitskaya was a crew member twice; she was the first of the woman cosmonauts to emerge into open space.

The cosmonauts worked a total of 13 times on the outer surface of the "Salyut-7" station. A great amount of complex work was done in the course of these emergences and valuable experience was accumulated in the assembly of large-size structures. A universal instrument was successfully tested for use in welding, cutting and soldering of metals and application of different kinds of coatings.

For the first time in world cosmonautics Leonid Kizim and Vladimir Solovyev, on the "Soyuz T-15" ship, made interorbital transfers and carried out work on two stations: "Salyut-7" and "Mir."

In the course of station operation an extensive program (more than 2,500 sessions) was carried out, which included geophysical, technical, astrophysical,

biomedical and technological experiments. A total of 175 items of scientific apparatus and equipment were used in the work. Numerous materials with the results of experiments and research with a weight of more than 500 kg were delivered to the earth.

In the field of geophysical research there were numerous seasonal surveys and spectrometric measurements of different areas of our country -- regions of the Ukraine, Krasnodarsk and Stavropol Krays, the Caucasus, Southern Urals, Central Asia and Far East.

The materials delivered to the earth, including more than 18,000 photographs pertinent to the mineral-raw material resources of the country, seasonal variability of agricultural fields and biological productivity of the world ocean, have been used by more than 500 user organizations in the interests of the economy.

There have been extensive multilevel comprehensive experiments with remote sensing of the earth within the framework of international programs with the simultaneous participation of the "Salyut-7" station, aircraft, ships of the USSR Academy of Sciences and special ground stations.

In the field of astrophysics new data have been obtained on galactic and extragalactic radiation sources, the interstellar medium and processes in near space. For the first time measurements have been made of the intensity and polarization of zodiacal light in the infrared spectral region. Considerable fluxes of the high-energy electron-positron component of cosmic rays over the region of the Brazilian Anomaly have been detected and investigated.

A cycle of research in the field of space materials science and technology has confirmed the technical-economic feasibility of organizing the production of different materials in space. Valuable data have been obtained on the effect of spaceflight factors on some construction materials, making possible reliable prediction of changes in their properties during prolonged operation of space vehicles. The successful implementation of work in open space with the augmenting of solar batteries, the testing of a universal hand-held tool, the repair of the combined engine and the deployment and investigation of a transformable girder is affording broad possibilities for the construction of new stations using large-size construction parts.

The medical experiments for the first time carried out aboard the station by a physician were devoted to study of the state of the cardiovascular, immune, analyzer, digestive and some other human functional systems.

The participation of the physician Oleg Atkov on the most prolonged expedition made it possible to obtain qualitatively new information on the peculiarities of the course of physiological, biochemical and psychological processes during space flight. Specially developed apparatus is being used both for improving the medical support of cosmonauts, and also in public health practice.

In the field of space biology it has been possible to ascertain the principal characteristics of reactions of biological objects of different levels of

organization -- from microorganisms to higher plants -- to exposure to space-flight factors. An experiment with the plant Arabidopsis, which under orbital flight conditions developed from seed to seed, ended with an important scientific and practical result. Agroengineering procedures for the cultivation of greens aboard the station for upgrading the ration consumed by cosmonauts have been developed and put into use. All this is evidence of the future possibility of development of closed life support systems.

In bioengineering experiments design and technological principles have been developed and improved upon which make it possible to construct space industrial apparatus for obtaining particularly pure medical preparations and the selection of highly productive strains of microorganisms. Work in orbit made it possible to obtain experimental consignments of preparations for the industrial production of vaccines and serums and also the first consignments of highly active microorganisms which can be used as fodder additives in livestock raising.

The work carried out on the "Salyut-7" orbital station became the latest stage in the development of space research, engineering and technology.

Today space engineering is standing at the threshold of development of manned, permanently operating orbital stations with a useful lifetime in the decades. The dimensions of such stations can attain several tens of meters and therefore in order to reduce the influence of aerodynamic perturbation they must be in higher orbits (about 500 km) than those at which our orbital complexes now fly. Accordingly, additional study of the characteristics of space at great altitudes is required: radiation, meteor streams, magnetic fields and others.

A solution of the problems involved in ensuring a long station operation lifetime requires a profound knowledge of the influence of real space medium factors of the flight trajectories on station materials and equipment.

That is why the decision to transfer the "Salyut-7"-"Cosmos 1686" complex into a higher orbit is in order, since it will make it possible to continue work with it under real flight conditions and to obtain data which are of interest to the developers of future space complexes. Now, after the corrections which have been made, the mean orbital altitude is 480 km and the lifetime of the complex will be not less than eight years.

At the beginning of the flight in high orbit plans call for carrying out telemetric radio monitoring of the state of the complex for the purpose of studying the lifetime characteristics and dynamics of change of parameters of systems and reliability of design decisions pertinent to ensuring seals of the living compartments and of the tanks, hydro- and pneumatic lines. It is also of interest to study the dynamics of lowering of the complex orbit for improving ballistic methods for predicting the parameters of motion.

With the exaustion of system service life, radio communication with the complex will cease. After several years it would be possible to send an inspection expedition to the complex to rendezvous with it. The expedition would carry

out a study of the condition of its structure and equipment of the complex and individual fragments of the structure, cables and solar batteries and some of the instruments will be demounted and brought to the Earth for study.

As a result it would be possible to obtain data on meteor conditions, condition of solar battery photoelements, stability of construction materials and processes in nonmetallic materials, etc.

Upon completion of the program of studies, a return of the station to the Earth to a predetermined region will be organized.

The flight of the "Salyut-7" station is continuing and its testing in the interests of further improvement in Soviet space technology is also continuing.

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SPACE SCIENCES

UDC 523.5

SELF-CONSISTENT GAS DYNAMIC MODEL OF SOLAR WIND FLOW AROUND COMET IONOSPHERE TAKING MASS LOADING INTO ACCOUNT

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 7, Jul 86 (manuscript received 20 Feb 86) pp 551-556

[Article by V.B. Baranov, M.G. Lebedev, USSR Academy of Sciences Institute of Space Research, Moscow and Moscow State University]

[Abstract] Solar wind flow around a comet produces three strong discontinuity surfaces: bow shock wave (F), contact discontinuity (S) and the internal shock wave in the cometary gas (H). Gas dynamic equations are written using a two-dimensional model for the continuity, motion, and energy and contain terms that take into account resonant charge transfer and photoionization. The boundary conditions required observance of the Rankine-Hugonio relation for the F and H shock waves and equality of the pressures and zero flow for the charged component at the S contact discontinuity. The self-consistent model was a function of five dimensionless parameters, one of which characterized the photoionization of the cometary neutrals and defines the "mass loading" process. The numerical solutions show the behavior of the F, S and H surfaces relative to the comet nucleus as a function of this mass loading parameter. Typical figures found for the surface distances from the nucleus are: $z_F = 5 \cdot 10^5$ km; $z_S = 4.2 \cdot 10^4$ km; $z_H = 3.3 \cdot 10^4$ km. The contact discontinuity is found to be a shear layer. The influence of the interplanetary magnetic field is disregarded; this can create the "magnetic barrier" effect which slightly reduces the distancing of the contact discontinuity from the core in the region of the axis of symmetry. The authors are grateful to A.A. Galeyev and V.D. Shapiro for their useful remarks and discussions. Figures 4; references 10: 4 Russian, 6 Western.

[142-8225]

/8309

SPACE SCIENCES

UDC 523.98

ORIGIN OF SERIES OF s-BURSTS IN SOLAR RADIO EMISSION

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 4, Apr 86
(manuscript received 8 Aug 85) pp 311-317

[Article by V.V. Zaytsev and Ye. Ya. Zlotnik, Applied Physics Institute,
USSR Academy of Sciences, Gorkiy]

[Abstract] A study was made of one type of fine structure of the frequency spectrum in solar radio emission (millisecond structure in meter spectra). This structure was registered using a spectrograph with high time and frequency resolution at 264 MHz. Observations were made at frequencies from 100 to 1000 MHz, supplemented at times of increased radio emission by observations using a spectrograph with a 2-MHz band. Millisecond bursts are observed rather frequently, regardless of the nature of general solar activity, whether it be type-III bursts or noise storms. It is demonstrated that the source of s-bursts is slightly anisotropic plasma with a quasihomogeneous magnetic field in which a group of hot electrons excites plasma waves near the frequency of the upper hybrid resonance. With scattering on thermal ions they are transformed into ordinary and extraordinary waves, for which the value of the refractive index is $n_{o,e} \ll 1$. A negative frequency drift is caused by a group lag during propagation of electromagnetic waves from the point $n_{o,e} = 0$ to emergence from the generation region. On the other hand, quasiperiodic series of bursts are related to a pulsating regime of conversion of plasma waves into ordinary and extraordinary waves. Figures 2; references: 6 Russian, 6 Western.

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SPACE SCIENCES

UDC 551.593.5

BRIGHTNESS OF SOLAR IMAGE OBSERVED FROM ARTIFICIAL EARTH SATELLITE IN VISIBLE SPECTRAL REGION

Moscow IZVESTIYA AKADEMII NAUK SSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 22 No 4, Apr 86 (manuscript received 10 Apr 84) pp 431-433

[Article by V.M. Prokhorov, Leningrad State University]

[Abstract] A study was made of the image brightness of the sun observable in the visible spectral region where lessening of atmospheric radiation consists of Rayleigh attenuation by air molecules, absorption by ozone in the Chappuis band and extinction by aerosol particles. The solar image observed from an artificial satellite with lowering of the line of sight will change with respect to both form and brightness of different parts. (The lower part of the image will always have a lesser brightness.) This phenomenon is evaluated quantitatively on the assumption that the atmosphere has spherical symmetry. Aerosol densities were found for two aerosol models, stratospheric and volcanic, air and ozone for three distributions of components with altitude. The following models were used: USSA, tropical and subarctic (data for these models were given by R.A. McClatchey, et al., AFCRL-72-0497, 1972). The results are tabulated for altitudes 13-45 km. The results can be used in interpreting photographic images of the sun obtained from an artificial satellite orbit and in designing systems for orientation on the solar image when studying vertical structure of the atmosphere. References 7: 4 Russian, 3 Western.

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CSO: 1866/112

UDC 521.13

TISSERAND POLYNOMIALS AND INCLINATION FUNCTIONS IN THEORY OF ARTIFICIAL EARTH SATELLITE MOTION

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 63 No 2, Mar-Apr 86 (manuscript received 30 Oct 84) pp 365-370

[Article by Ye. P. Aksenov, State Astronomical Institute imeni P.K. Shternberg]

[Abstract] Tisserand polynomials $T_{p,q}^{(n)}$ were introduced by Tisserand in TRAITE DE MECANIQUE CELESTE, Vol 1, Paris, 1969, and were interpreted by Poincare as a special case of hypergeometric polynomials of two variables. Inclination functions $A_{n,m}^{(k)}$ (I) appeared in the 1960's in connection with development of the theory of motion of artificial earth satellites. They were introduced by W.M. Kaula in GEOPHYS. J., Vol 5, p 104, 1961, for expanding the perturbing function of the earth's asphericity. There is a definite relationship between Tisserand polynomials and inclination functions: each Tisserand polynomial corresponds to a definite inclination function, differing from it only by a constant factor (although certain inclination functions have no Tisserand function analogues). It is therefore possible to use the method for computing the $A_{n,m}^{(k)}$ functions which has been recently developed for computing the $T_{p,q}^{(n)}$ polynomials. Some applications of Tisserand polynomials and inclination functions for solving some problems in celestrial mechanics are examined: satellite problem of three bodies and perturbing function in theory of motion of artificial earth satellites. References 9: 5 Russian, 4 Western.

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CSO: 1866/104

SPACE SCIENCES

OPTIMUM NONLINEAR FILTERING OF RADIOASTRONOMY OBSERVATIONS

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 63 No 2, Mar-Apr 86 (manuscript received 17 Jun 85) pp 399-401

[Article by A.G. Gorshkov and I.K. Rozgacheva, State Astronomical Institute imeni P.K. Shternberg]

[Abstract] A method is proposed for the processing of radioastronomical observations which makes it possible to obtain an optimum evaluation of the flux density distribution function for sources without a direct count of the sources. The method involves study of the $x(\alpha)$ record of sky radiation distorted by uncorrelated noise of an unknown nature (α is the angular coordinate). The probability density function for the flux values $F = Sf$ (S is the source flux, $f(\alpha)$ is the polar diagram) is described by the function $q(F, \alpha)$, the probability density that the flux F will be detected in a given interval $(\alpha, \alpha+\Delta\alpha)$. The $x(\alpha)$ record can be regarded as a record of a pulsed process in which $x(\alpha)$ assumes the value $x_0(\alpha)$, representing transitions from the state x to the state x_0. The $x_0(\alpha)$ process consists of a series of x_0 pulses with random durations and with random intervals between them. Then $\omega(x_0, \alpha)$ is the probability density of the pulsed process x_0. The function of two variables $\omega(x_0, \alpha)$ is described by the Kolmogorov-Feller integro-differential equation, which can then be used in describing the statistics of a random signal. Figures 1; references 5: 3 Russian, 2 Western.

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UDC 550.383

FINE STRUCTURE OF ELF HISS ENERGY SPECTRA AT AURORAL LATITUDES (INTERCOSMOS-14 SATELLITE)

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 26 No 2, Mar-Apr 86 (manuscript received 19 Jun 85) pp 342-344

[Article by G.A. Mikhaylova, O.V. Kapustina, and Yu. M. Mikhalyov, Institute of Terrestrial Magnetism, the Ionosphere and Radio Wave Propagation, USSR Academy of Sciences]

[Abstract] The location of the source of and mechanism for the generation of ELF hisses regularly observed in the outer ionosphere by means of satellites are not at all clear. The results are presented from the digital processing of ELF hiss signals on board the Intercosmos-14 satellite. Tape recordings were made of the amplitude of the magnetic component of ELF hisses in the frequency range of 300 to 2000 Hz during the period from 5 March to 11 May 1976. A digital spectrum analyzer was used for the purpose of determining the spectral power density of hisses and studying its dynamics over time. The results obtained confirm the earlier observed characteristic features of the energy spectra of ELF hisses at auroral latitudes. There are two noise bands with central frequencies of 490 to 550 and 670 to 730 Hz lying on both sides of the local proton gyrofrequency. The spectral power density of these bands undergoes considerable variations over time. This type of hiss, designated Group I, was observed in a rather narrow latitude band of approximately 2°, and relatively infrequently. Group II is characterized by the presence of a single relatively narrow (approximately 100 Hz) noise band whose central frequency is higher than the local proton gyrofrequency and the spectral power density is intensity-modulated. Signals of Group I were observed primarily at an invariant latitude, Φ', of 58 to 65 degrees, and signals of Group II, at $\Phi \sim 68 \pm 2$ degrees. The two types of ELF hiss are both observed in the morning sector of the magnetic local time (MLT). Protons with energy on the order of a dozen keV are observed at auroral and subauroral latitudes in the morning sector, and it is assumed that they are responsible for the amplication of ELF hisses at the polar boundary of the principal ionospheric trough, and for the formation of their multiplet structure. These protons drift eastward after injection during a substorm. A diagram is presented of the space-time separation of the two types of ELF hiss in the high-latitude outer ionosphere in invariant latitude--local time coordinates. Figures 2; references 7: 4 Russian, 3 Western.

[120-8831]

SPACE SCIENCES

UDC 523.165

PROBLEMS AND METHODS OF STUDYING HIGH ENERGY PARTICLES BEYOND THE ATMOSPHERE

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: FIZIKA, ASTRONOMIYA in Russian
Vol 27 No 1, Jan-Feb 86 (manuscript received 7 Aug 85) pp 8-13

[Article by N.L. Grigorov, I.D. Rapoport and V.Ya. Shestoperov]

[Abstract] The Cosmic Ray Section at Moscow State University Scientific Research Institute for Nuclear Physics has developed over the past two decades comprehensive instrumentation hardware and techniques for the measurement of primary cosmic ray energy spectra in a range of 10^{11} to 10^{15} eV. The energy spectra of He protons and nuclei differ: the proton spectrum is "steeper" at energies above 10^{12} eV than that of all other nuclei. The inelastic collision cross-sections increase with an increase in the proton energy above 10^{11} eV. These initial data from mountain-top measurements were subsequently confirmed by satellite and accelerator measurements. Many research institutes in the USSR are working under the rubric of the DYUMAND program which studies the interaction of cosmic ray muons and neutrinos with matter at extremely high energies. The accuracy of the experimentation improves as the flux and spectrum of the particles being studied are known better. These data can only be found by calculations that depend on knowledge of the spectrum and composition of primary cosmic rays and their interaction with the atomic nuclei in the atmosphere. A secondary goal is the use of direct measurements at energies of 10^{14} to 10^{16} eV to come up with techniques that make it possible through the analysis of broad atmospheric showers to uniquely ascertain the composition of cosmic rays at energies above 10^{16} eV where direct measurements are impossible. Data from such an "Intercosmos-6" experiment led to the important conclusion that the process of multiple particle generation during the interaction of complex high energy nuclei (above about 1 TeV) does not reduce to the simple superposition of the elementary nucleon-nucleon or nucleon-nuclear interactions. The track of a 20 TeV nucleus through the SOKOL ionization calorimeter is shown graphically based on the Intercosmos-6 data, as part of the next stage, which has two goals: the detail study of the chemical composition of cosmic rays at energies of 1 to 100 TeV, particularly, the proton component, and the determination of the parameters of nuclei interaction.

The SOKOL calorimeter has 95 photoelectron multipliers, 200 amplitude analyzers and a power consumption of only 9.8 watts. This instrument was used for cosmic ray measurements on the Cosmos-1543 satellite. In upcoming years, the Cosmic Ray Section plans repeat measurements of the charge and energy spectra of primary cosmic ray particles in a wider energy range of up to 10^{15} eV and the study of nuclei-nuclei interactions at energies above about 10 TeV. Figures 5; references 14: 12 Russian, 2 Western.

[144-8225]

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SPACE SCIENCES

UDC 523.165

PLANETARY DISTRIBUTION OF SECONDARY CHARGED PARTICLES OUTSIDE EARTH'S RADIATION BELTS

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: FIZIKA, ASTRONOMIYA in Russian
Vol 27 No 1, Jan-Feb 86 (manuscript received 24 Jun 85) pp 13-15

[Article by Ye.V. Gorchakov, V.G. Afanasyev, K.G. Afanasyev, P.P. Ignatyev, V.A. Iozenas, and M.V. Ternovskaya]

[Abstract] The Cosmos-900 satellite in a practically circular orbit at about 500 km carried a global Cerenkov counter with a large geometric factor of about 0.9 $m^2 \cdot sr$ and good time resolution of about 20 s. This counter was used to study the longitude and latitude distribution of charged particles between March 1977 and October 1979. The count rate for electrons with energies above 15 MeV and protons above 400 MeV, as well as the magnetic field intensity are plotted as a function of the geographic longitude for various L-shells in the northern hemisphere, where the data was obtained during the geomagnetically quiet time. The count rate is a function of longitude for magnetic shells in the region of the middle latitudes; the secondary particle flux for a given L increases with an increase in the geomagnetic induction. The longitude function in the various magnetic shells is independent of local time, thus indicating the spatial nature of the phenomenon. In the northern hemisphere, these data correspond to drift trajectories passing through the earth, so that the detected particles are not considered trapped. Since the secondary radiation source is in the near-Earth atmosphere, it is natural that the intensity of this radiation must be a maximum at those longitudes where the maximum magnetic field induction is observed. Figures 3; references 8: 6 Russian, 2 Western.

[144-8225]

/8309

SPACE SCIENCES

UDC 537.591

STUDY OF ENERGETIC PARTICLE GENERATION CONDITIONS IN SOLAR FLARES

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: FIZIKA, ASTRONOMIYA in Russian
Vol 27 No 1, Jan-Feb 86 (manuscript received 27 Jun 85) pp 16-22

[Article by Yu.I. Logachev and V.G. Stolpovskiy]

[Abstract] The Prognoz-5 and -6, IMP-7 and -8 high apogee satellites as well as the Venera interplanetary probe recorded 300 solar cosmic ray flares. The electron fluxes were measured at energies of E_e = 0.025 to 1.6 MeV, the proton fluxes at E_p = 1 to 60 MeV, as well as the X-ray quanta at E_x = 0.05 to 0.75 MeV. The distribution of the number of flare events is analyzed as a function of the maximum electron, hard and thermal X-radiation fluxes. A good correlation is found between the amplitudes of the flare electron and thermal X-radiation fluxes. Two types of events occur in solar cosmic rays: those accompanied and those not accompanied by hard X-radiation bursts. The propagation of particles in the interplanetary medium is described by a diffusion equation and the mean free path of the particles is practically independent of energy in a range of 1 to 100 MeV/nucleon. A graph of the differential energy spectra as a function of the intensity maxima in various components of the solar cosmic rays during a flare (for electrons, protons, alpha particles, Fe, S, C, Mg and O) shows that the electron, proton, alpha particle and heavier nuclei spectra have similar slopes, thus indicating that all of the particles are accelerated during the same time and in the same range of altitudes in the solar atmosphere. The authors are deeply grateful to Ye.I. Daybog for his useful discussions and the quantitative estimates. Figures 5; references 18: 7 Russian, 11 Western.

[144-8225]

/8309

UDC 532.165

STUDY OF EARTH'S MAGNETOSPHERE BASED ON INVESTIGATION OF CHARGED PARTICLE FLOWS

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: FIZIKA, ASTRONOMIYA in Russian
Vol 27 No 1, Jan-Feb 86 (manuscript received 28 Jun 85) pp 22-27

[Article by P.V. Vakulov and S.N. Kuznetsov]

[Abstract] Present models describing the structure of the magnetosphere are statistical and inadequately precise at distances of more than four to five earth radii, where the structure is more variable and the characteristic regions are more conveniently defined by studying the distribution of the charged particles in the magnetosphere. Data from the Cosmos-426 satellite on the capture boundary for electrons (intensity of $5 \cdot 10^3$ $cm^{-2} \cdot s^{-1} \cdot sr^{-1}$) at energies of more than 20 keV are plotted as a function of the MLT in order to ascertain the position of the polar cap and plasma layer boundaries, as well as the degree of agreement with various models. Data for electron energies above 30 keV obtained from the Cosmos-484 in April 1972 are also adduced. Additional information on the magnetosphere structure is gained from investigating the structure of low energy solar cosmic rays. Data from six successive passes of the Intercosmos-17 satellite through the high latitudes near the noon-midnight meridian are shown in the form of a plot of the solar cosmic ray electron fluxes as a function of local time at these latitudes. Two mechanisms for the intrusion of solar cosmic ray electrons into the plasma layer are discussed: 1) Magnetic drift in the tail of the magnetosphere from the evening to the morning side; 2) Electrical drift of the electrons in the convection field. The influence of solar wind pressure and the dipole inclination angle in the plane of the noonday meridian perpendicular to the ecliptic is discussed in light of data from the Intercosmos-17 obtained in November 1977 and February 1978. The structure of the particle distributions at low altitudes makes it possible to not only qualitatively describe the magnetosphere structure, but also qualitatively estimate the position of the boundaries of certain structural formation as a function of the parameters of the interplanetary medium. Figures 3; references 12: 8 Russian, 4 Western.

[144-8225]

/8309

UDC 523.72

STUDY OF FINE STRUCTURE OF SHOCK WAVES USING 'BIFRAM' PLASMA SPECTROMETER COMPLEX

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86 (manuscript received 23 Dec 85) pp 151-165

[Article by G.N. Zastenker, O.L. Vaysberg, Z. Nemechek, Ya. Shafrankova, A.O. Fedorov, Yu. I. Yermolayev, A.V. Leybov, M. Rikhter, V. Ganzal, N.L. Borodkova, A.A. Skalskiy, V.N. Smirnov, Ye. A. Gavrilova, N.V. Plyusnina and A.N. Omelchenko]

[Abstract] The BIFRAM complex of plasma spectrometers is one of the fundamental instruments used in the INTERSHOCK program. It is intended for measuring the structure of the distribution function for solar wind particles. Its use made it possible to analyze a great volume of data obtained with a high temporal resolution during intersection of the front of a quasiperpendicular turbulent shock wave on 7 May 1985. Use of the BIFRAM energy and angle mass spectrometer made it possible to register the dynamic energy spectrograms of protons, α-particles and electrons, oscillations of the longitudinal and transverse components of the magnetic field and the plasma flow and fluctuations in the flows of ions and electrons in narrow energy ranges. This made it possible to define the sequence of development of events on the shock wave front. First there is a region of development of high-frequency oscillations of the plasma flow and the magnetic field, reflected conspicuously in the dynamics of ion and electron distributions. Then a quite extended region appears with lower-frequency oscillations of the plasma flow and magnetic field, with a gradual heating of the electron component and an increase in the magnetic field. Next a narrow region appears with a sharp jump of the magnetic field behind which strong low-frequency oscillations develop and the high-frequency oscillations drop off. Finally, an extremely elongated region appears in which the ion distribution function is smoothed in the transition region. Figures 8; references 19: 8 Russian, 11 Western.

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CSO: 1866/117

SPACE SCIENCES

UDC 551.521.8

DYNAMICS OF ION DISTRIBUTION FUNCTION NEAR CIRCUMTERRESTRIAL SHOCK WAVE FRONT (11 May 1985)

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86 (manuscript received 27 Dec 85) pp 166-176

[Article by O.L. Vaysberg, G.N. Zastenker, V.N. Smirnov, Z. Nemechek, Ya. Shafrankova, L.A. Avanov and Ye. I. Kolesnikova]

[Abstract] In preparations for the INTERSHOCK project considerable importance was assigned to observations of the ion distribution function because the problem of heating of ions on the front of a strong quasiperpendicular shock wave could not be considered solved. It was surmised that if the ion distribution function sections could be measured with sufficiently high energy, angular and time resolution it would be possible to study the mechanisms of energy dissipation in such a shock wave. Such measurements required a method for registry of a number of measured parameters in a direct transmission regime using the standard satellite telemetric system. Two-hour measurement periods were planned in such a way as to increase the probability of registry of a circumterrestrial shock wave. This required introduction of a number of innovations. Transmission procedures and results are illustrated in the example of the transmission of 11 May 1985 when a circumterrestrial shock wave twice passed the satellite during the measurement period. The first shock wave can be regarded as a supercritical turbulent quasiperpendicular shock wave, whereas the second was a supercritical turbulent quasiparallel shock wave. It was concluded that the ion distribution function behind the front of a strong shock wave has an extremely fine and nonuniform structure. On the shock wave front the potential jump can have a small spatial structure with an extent of $\sim$5 km. Figures 8; references 14: 3 Russian, 11 Western.

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SPACE SCIENCES

UDC 523.72

INVESTIGATION OF PLASMA WAVES USING 'BUDVAR' COMBINED WAVE DIAGNOSIS COMPLEX ('PROGNOZ-10-INTERCOSMOS')

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86 (manuscript received 23 Dec 85) pp 177-184

[Article by S.I. Klimov, M.N. Nozdrachev, P. Triska, Ya. Voyta, A.A. Galeyev, Ya. N. Aleksevich, Yu. V. Afanasyev, V. Ye. Baskakov, Yu. N. Bobkov, R.B. Dunets, A.M. Zhdanov, V. Ye. Korepanov, S.A. Romanov, S.P. Savin, A. Yu. Sokolov and V.S. Shmelev]

[Abstract] The Soviet-Czechoslovakian INTERSHOCK project, emphasizing research on the fine structure of circumterrestrial and interplanetary shock waves, included study of plasma waves and a more complete analysis of the mechanism of collisionless dissipation of the kinetic energy of plasma flow at the shock wave front. The BUDVAR experiment, part of INTERSHOCK, centered on study of the fine structure of wave processes in the entire range of plasma frequencies with an optimum frequency and time resolution, was fully described by Yu. F. Afanasyev in INTERSHOCK PROJECT, Astr. Inst. of the Czech. Acad. of Sci., Publ. No 60, 1985. The BUDVAR experiment was facilitated by use of the BROD computer complex. The article describes the main features of wave diagnosis in this experiment. Examples of measurements in circumterrestrial shock waves are given, as well as the first results of physical interpretation of processes transpiring at the front. A detailed analysis of wave data is given for the shock wave intersection of 11 May 1985. It was found that for the case of a strong quasiperpendicular shock wave the main mechanism leading to the dissipation of energy of the directed flow of solar wind plasma is the generation of strong magnetosonic oscillations at frequencies substantially less than the frequency of lower hybrid resonance. It was possible to describe the frequency-spatial characteristics of the registered radiations and explain the observed relationship of amplitudes of fluctuations of the electrical and magnetic fields. New results were obtained on ELF radiations in the neighborhood of the shock wave and at the magnetopause. Figures 6; references 20: 12 Russian, 8 Western.

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CSO: 1866/117

UDC 533.9

STUDY OF HIGH-ENERGY PARTICLES ASSOCIATED WITH SHOCK WAVES WITHIN FRAMEWORK OF INTERSHOCK PROJECT (EChNUV EXPERIMENTAL COMPLEX)

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86
(manuscript received 15 Dec 85) pp 185-191

[Article by M. Vandas, K. Kudela, V.N. Lutsenko, Z. Memechek, M. Slivka, S. Fisher and Ya. Shafrankova]

[Abstract] It is now generally accepted that collisionless shock waves in cosmic plasma are the principal generators of high-energy particles and cosmic rays, accounting in part for the stress placed on study of circumterrestrial shock waves in the INTERSHOCK project. The EChNUV (enegichnyye chastitsyy na udarnoy volne--high-energy shock wave particles) complex used in INTERSHOCK measurements was for collection of data on the composition, spectra and pitch angle distributions of such particles. The complex consisted of five instruments (AKME, DOK-1, DOR-0, DOR-R, TP-3) for measuring time variations of particle fluxes, their composition, spectra and angular distributions in the energy range from 1 keV to 20 MeV. Each of these instruments is briefly described; a table gives the technical specifications of each and the parameters registered by each. All the EChNUV complex instruments operated continuously from 26 April 1985 to the end of the active lifetime of the satellite in mid-November 1985. The operating regimes of the complex and its functioning are discussed. The results are illustrated using data obtained for intersection of a circumterrestrial shock wave on 7 May 1985. (During the 6.5 months the shock wave was intersected more than 500 times, in over 60 cases with a high temporal resolution.) The responses of all sensors and ratemeter ranges were suitable for the particle fluxes observed in the shock wave in the transition region and the outer magnetosphere. The EHcNUV demonstrated its suitability for registry of many phenomena associated with high-energy particles in the solar wind and in the earth's magnetosphere, as well as in the circumterrestrial shock wave. Figures 5; references: 2 Russian.

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EXPERIMENT FOR DETERMINING ION COMPOSITION OF SOLAR WIND USING MASS-ENERGY ANALYZERS IN 'BIFRAM' COMPLEX

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86 (manuscript received 27 Dec 85) pp 192-199

[Article by Yu. I. Yermolayev, G.N. Zastenker, V.T. Kogan, G.Ye. Kocharov, B.V. Koshevenko, A.V. Leybov, Z. Nemechek, A.K. Pavlov, A.O. Fedorov, A.A. Kharchenko, Yu.V. Chichagov and Ya. Shafrankova]

[Abstract] The mass and energy analyzers of the BIFRAM plasma complex, used in the INTERSHOCK project, made it possible to determine the ion composition of the solar wind. The principles of operation and some characteristics of two types of sensors are described--an electrostatic analyzer with a Wien filter for separate measurement of the kinetic parameters of both protons and α-particles and a new type of two-capacitor analyzer with a magnet for measuring the energy spectra of heavy ions. Selective measurements were made of fluxes of protons and α-particles with a high temporal resolution, ion fluxes with A/Z in the range from 2 to 8 with orientation primarily on the oxygen ions O^{+6} and O^{+7}, iron ions from Fe^{+7} to Fe^{+12} and ensembles of the ions (Si^{+8}, $+9$, $+10$) and ($^4He^+$, Si^{+7}, S^{+8}, Ar^{+9}, Ca^{+10}). Joint measurements of oxygen and iron ions afford a possibility for obtaining information on electron temperature in the broadest part of the corona, the region most important in formulating models of solar wind origin. For illustrating the capabilities of the BIFRAM complex, the example is given of measurements of the total spectrum of energies and masses of solar wind ions on 7 May 1985. Among the heavy ions it was possible to make a reliable identification of iron ions from Fe^{+10} to Fe^{+13}, oxygen ions O^{+6} and O^{+7} and groups of ions with A/Z = 3.1, 3.2 and A/Z = 3.5, 3.56, 4.0, which in all probability are Si and S ions. These and other data will make it possible to obtain good information on T_e and grad T_e in the corona and estimate the kinetic temperature of heavy ions as a function of solar wind characteristics. Figures 5; references 18: 7 Russian, 11 Western.

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SPACE SCIENCES

DYNAMICS OF SATELLITE MOTION AND SIMULATION OF SITUATIONS IN INTERSHOCK PROJECT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86
(manuscript received 27 Dec 85) pp 200-209

[Article by M.N. Boyarskiy, G.N. Zastenker, V.P. Pavlov, V.I. Prokhorenko, V.N. Smirnov, A.I. Sheykhet and N.A. Eysmont]

[Abstract] The INTERSHOCK project, implemented using the "Prognoz-10-Intercosmos" satellite, was for the study of shock waves in cosmic plasma with a high time resolution. Ballistic support of the work required solution of a series of problems: choice of the most suitable satellite orbit from a family of orbits of satellites of the "Prognoz" type; simulation of intersections of the selected trajectory with the surface of the circumterrestrial shock wave for the purpose of timely prediction of the moments of these intersections; speedy analysis of the real position of these intersections for routine correction of the model used; analysis of the real motion of the satellite relative to its center of mass, necessary for determining the orientation of the axes of different scientific instruments at any moment in time. The approaches used in solving each of these problems are discussed in detail. The results of determination of the position of the circumterrestrial shock wave for a half-year of satellite flight (April-November 1985) are given. Forty-seven intersections were registered; most of these intersections were multiple and therefore about 440 intersections were recorded during the entire active lifetime of the satellite. Eighteen intersections were registered with a high time resolution. The 440 cases of recorded intersections were used in determining the mean position of the shock wave, giving a distance to the subsolar point of the shock wave of $13.2R_E$ and to the flank $23.3R_E$. This mean position is $1.5\text{-}2R_E$ closer to the earth than predicted in the Formisano model. The front experiences considerable $(1.5\text{-}2)R_E$ fluctuations relative to the mean position and in some cases these deviations attain $(7\text{-}9)R_E$. Figures 4; references 12: 9 Russian, 3 Western.

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UDC 681.142.4

EXPERIENCE WITH USE OF ON-BOARD INFORMATION-COMPUTER SYSTEM FOR DATA PROCESSING AND CONTROL IN INTERSHOCK EXPERIMENT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86 (manuscript received 27 Dec 85) pp 210-216

[Article by V.F. Babkin, K. Kudela, V.N. Lutsenko, M.Ya. Natenzon, L.V. Pesotskiy, A. Sedlachek, S. Slaby, Ya. Tomek and S. Fisher]

[Abstract] The main objective in the INTERSHOCK experiment was collection of data on the physical characteristics of a shock wave intersected by a satellite during its motion in orbit. The required time resolution for registry of processes in the shock wave front was 10-100 times greater than the capabilities of the standard telemetric system. The main instrument used in the registry of shock waves was the BROD (blok registratsii i obrabotki dannykh--block for registry and processing of data) supplied with a microcomputer for ensuring a high temporal resolution when recording physical processes in the shock wave region. In the BROD instrument use was made of an adaptive principle for making measurements in which the frequency of interrogation of the registered parameters is automatically increased in the zone of development of physical processes associated with the appearance of shock waves and is reduced in sectors with an insignificant change in the characteristics of the measured processes. Whereas the telemetric system had but 50-60 channels, the BROD complex had 400. The functional capabilities of the BROD complex are discussed in detail; a block diagram with 32 components identified serves as a basis for this discussion. The informational support for the experiment, control and reprogramming are outlined. It was possible to achieve highly effective compression of data (by a factor of 18) by using the DOR-0 monitor (described by M. Vandas, et al., in this same issue of the journal, pp 185-191). Figures 3; references 5: 4 Russian, 1 Western.

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UDC 681.142.4

EVALUATING EFFECTIVENESS OF USE OF ADAPTIVE PRINCIPLES FOR REGISTRY OF DATA AND CONTROL OF SCIENTIFIC INSTRUMENTATION IN 'INTERSHOCK' EXPERIMENT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86 (manuscript received 27 Dec 85) pp 217-227

[Article by V.F. Babkin, Yu.I. Yermolayev, V.I. Zhuravlev, G.N. Zastenker, M.Ya. Natenzon, S. Slaby, A Sedlachek, Ya. Tomek and M.I. Shevchenko]

[Abstract] The use of adaptive principles in the registry of data and control of scientific instrumentation was required for achieving the main goal of the INTERSHOCK program: registry of the fine structure of shock waves in cosmic plasma. This required identification of the moment of passage of a shock wave by satellite instrumentation and optimum distribution of computer memory capacity. These problems were solved using the BROD electronic computer, connected to the entire complex of scientific instrumentation (this computer was described by V.F. Babkin, et al. in this same issue of the journal, pp 210-216). This article describes the physical principles and algorithms for solution of control problems and the results of their application in the course of implementation of the INTERSHOCK experiment on the "Prognoz-10-Intercosmos" satellite (April-November 1985). The algorithms for shock wave detection are discussed in detail. Two groups of tests are proposed for determining intersection of a shock wave: solely on the basis of magnetic data or solely on the basis of plasma data, or with use of all tests in both groups or use of at least one group of tests. An algorithm for allocation of computer memory space is also outlined. During the experiment it was possible to obtain 41 records containing data on shock wave intersection. The careful choice of the most suitable physical parameters and constants for the detection algorithm ensured a high probability of correct detection of shock waves and a low number of spurious triggerings. The detection algorithms are useful for other purposes than shock wave identification. Figures 4; references 19: 12 Russian, 7 Western.

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UDC 551.521.6

STUDIES OF LONG-WAVE COSMIC RADIO EMISSION ON 'PROGNOZ-10-INTERCOSMOS' ARTIFICIAL EARTH SATELLITE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86 (manuscript received 27 Dec 85) pp 228-234

[Article by V.P. Grigoryeva, V.N. Kurilchik, S. Pinter, A. Tirpak, O.B. Likin, L. Fisher, A. Yaroshevich, A.B. Delone and Ye. A. Makarova]

[Abstract] A multichannel radiometer was used on the "Prognoz-10-Intercosmos" satellite in carrying out the AKR-2M experiment for studying long-wave cosmic radio emission under the INTERSHOCK program. Different types of radio emission bursts of solar origin were registered during the period late April-November 1985. Auroral kilometric radio emission of the Earth's magnetosphere was also systematically registered. Relatively few events of long-wave radio emission were registered because the measurements were made at the solar activity minimum. Only a few dozen events were recorded. The examples cited are the events of 13 and 15 September 1985 (data obtained in the optical and x-radiation ranges were also used). It was possible to study the relationship between phenomena in the solar chromosphere observed in the optical and x-radiation ranges and phenomena in the interplanetary medium observed in the long-wave range. Particular attention was given to observations of kilometric radio emission in the Earth's magnetosphere. This emission was registered at altitudes of about 1.5-3R_E near the northern auroral zone where it was registered in all frequency channels, especially at 750, 1000 and 1500 KHz. A table gives statistical data characterizing the presence or absence of generation of auroral kilometric radio emission in the auroral region during 42 successive transits of the "Prognoz-10." These data indicate that generation of this emission in the auroral zone is characterized by broadening of the frequency range into the high-frequency region. Evidence was obtained of compactness of the region or its individual structural zones in which this emission is generated and on the different directivity of radiation at different frequencies. The observed phenomena can be classified as a hectometric continuation of kilometric radio emission. Figures 5; references: 11 Western.

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SPACE SCIENCES

UDC 551.521.8

MICROSTRUCTURE OF CIRCUMTERRESTRIAL SHOCK WAVE FRONT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86
(manuscript received 10 Dec 85) pp 235-245

[Article by O.L. Vaysberg, V.N. Smirnov and L.A. Avanov]

[Abstract] Data from high-frequency measurements of a series of plasma parameters on a shock wave front obtained with the "Prognoz-8" satellite were analyzed. This represents a continuation of research on this subject using data from this same satellite. Other articles gave an analysis of data from wave and plasma measurements making it possible to detect powerful perturbations in the region of lower hybrid resonance responsible for ion heating on the front (O.L. Vaysberg, et al., PISMA V ZhETF, 35, No 1, p 25, 1982), the oblique waves associated with them, responsible for electron heating (O.L. Vaysberg, et al., ZhETF, Vol 85, No 4(10), p 1232, 1983) and the interrelationships between the behavior of plasma and the nature of wave oscillations (O.L. Vaysberg, et al., ADV. SPACE RES., No 2-3, p 265, 1984). This preliminary work made it possible to analyze measurements of plasma flow and electrical field fluctuations and the flux of ions with a high time resolution on the fronts of two strong quasiperpendicular shock waves. Additional evidence was obtained indicating well-developed lower hybrid, whistler and magnetosonic turbulence in the region of the "foot" of such a strong quasiperpendicular shock wave. Saturation of waves of the lower hybrid type in this region is accompanied by threshold excitation of turbulence in the ion flux. Compact wave packets of extremely low-frequency waves of a great amplitude, a result of collapse of ELF oscillations, were registered. The periodicity of bursts in the ELF range of oscillations with a period on the order of the gyroperiod of protons indicates that reflected ions are the source of the observed turbulence. A sharp decrease in the amplitude of ELF turbulence on the trailing edge of the shock wave virtually coincides with the region of thermolization of ions. A dispersion curve similar to the dispersion curve of magnetosonic oscillations was constructed and the scale of the observed phenomena was evaluated. Small-scale nonlinear structures with a depression of the plasma concentration and saturated ELF oscillations of a great amplitude were discovered. Figures 7; references 30: 15 Russian, 15 Western.

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SPACE SCIENCES

UDC 629

GAMES EVALUATION PROBLEM WITH NON-SIMULATION ACCELERATIONS AND ALGORITHM FOR ITS SOLUTION

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86
(manuscript received 27 Nov 85) pp 246-276

[Article by M.L. Lidov]

[Abstract] The problem of minimax evaluation with non-simulation accelerations was previously dealt with in the greatest detail by V.A. Arkhangelskiy, et al. (KOSMICH. ISSLED., Vol 17, No 3, 1979); that study was prepared on the basis of pioneering work by M.L. Lidov in KOSMICH. ISSLED, Vol 2, No 5, 1964. This problem has been explored in great depth, being regarded as a classical differential game. It is shown how the necessary minimax conditions can be obtained. The additional analysis which has been made has made it possible to formulate, in the form of a fundamental theorem, a full set of adequate conditions (including all the necessary conditions) which ensure satisfaction of the saddle point inequalities. Several simple problems are solved analytically and serve as an illustration of use of adequate conditions. A general computation algorithm is proposed for solving such problems. This algorithm is based on construction of solutions in a single-parameter family of problems with a gradually increasing influence of unsimulatable accelerations, beginning with a zero acceleration. The testing of the algorithm in examples which had first been analyzed analytically is described. Figures 1; references: 4 Russian.

5303/8309
CSO: 1866/117

SPACE SCIENCES

UDC 521.1

ONE FAMILY OF ALMOST CIRCULAR ORBITS IN INTERNAL VARIANT OF AVERAGED ELLIPTICAL THREE-BODY PROBLEM

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86 (manuscript received 15 Dec 85) pp 277-281

[Article by V.P. Yevteyev]

[Abstract] It is shown that there is a class of periodic orbits in the internal variant of the averaged elliptical three-body problem. The problem is formulated as follows. It is assumed that the material points P_0 and P_1 have the masses m_0 and m_1. The point P_0 revolves around P_1 with the mean angular velocity n in a Keplerian elliptical orbit. The equations of motion of a third passively gravitating body P are then written. With this point of departure, proof is presented of the existence of periodic solutions. A modification of the small parameter method is used. The convergence of the constructed solutions is demonstrated and the region of their convergence is indicated. Three theorems are written demonstrating the validity of these conclusions. References: 5 Russian.

5303/8309
CSO: 1866/117

INTERPLANETARY SCIENCES

COMMENTARY ON PHOBOS PROJECT

Riga NAUKA I TEKHNIKA in Russian No 3, Mar 86 pp 6-8

[Article by Yuriy Zaytsev, Space Research Institute, USSR Academy of Sciences]

[Text] **Initially the attention of scientists was directed for the most part to the planets in studies of the solar system. Now it is directed more to comets, asteroids and small planetary satellites. Among the most mysterious of these are the Martian satellites Phobos and Deimos.**

The study of planets by space vehicles began 25 years ago, from the very day when a multistage rocket in the Soviet Union put the "Venera-1" automatic station in a flight trajectory toward the planet Venus. Thus was laid the first interplanetary trajectory.

The tasks became more complex and methods and scientific instruments were improved from flight to flight.

Direct exploration revealed natural complexes differing considerably from our planet. The main interrelationships and the specifics of formation of these complexes are of special interest because they bring us closer to an understanding of what occurred in the solar system in the past and what can be expected in the future. For example, it has been confirmed that there is a unity of the elemental and mineralogical composition of the matter of planets and meteorites. It was found that thermal evolution, volcanic and tectonic activity and geological structure on the planets of the earth group are similar. Successes in a new scientific discipline -- comparative planetology -- will govern, in particular, our understanding of the fundamentals of the earth's nature. Even today it is possible to speak of comparative geology, comparative meteorology and comparative climatology, it is now possible to relate origin of celestial bodies to nuclear and chemical evolution of solar system matter and as a result, we are now able to understand the reasons for uniqueness of the earth's nature which led to the appearance and development of life here.

But up to the present time emphasis has been on large bodies: planets and their large satellites. "Now," notes R. Z. Sagdeyev, director of the Space Research Institute, USSR Academy of Sciences, "the interests of researchers have turned

to a completely different class of objects in the solar system, small bodies like comets and asteroids. The fact is that due to the small mass of these bodies and their considerable distance from the sun they could preserve within their structure the 'primary' matter of the original gas-dust nebula from which the solar system was formed and thereby retain very important information on the initial stage in its formation."

An important step in this direction was the launching of the automatic interplanetary stations "Vega-1" and "Vega-2 and study of Halley's comet.

Soviet scientists are already thinking about new, still more grandiose projects. The sending of a space vehicle into the asteroid belt is extremely interesting. It is possible to select such a vehicle trajectory that in several revolutions around the sun the vehicles would encounter at least 10 asteroids. In this process the space vehicle would have to return regularly to a distance close to the earth.

The essence of the idea is as follows: after launching from the earth the station is put into an orbit with a period of revolution equal to a whole number of years. Thus, if the station is put into an orbit with a perihelion of 1 astronomical unit (1 a.u. $\approx$ 150 million kilometers, that is, the mean distance from the earth to the sun), and an aphelion of 2.17 a.u., the period of its revolution around the sun would be 2 years. If the aphelion is equal to 3.16 a.u., the station period of revolution will increase to 3 years.

Thus, we are visualizing such a space vehicle which each 2 or 3 years will return to the earth in order to then enter the next revolution of a heliocentric orbit. The earth's gravity field in this case will serve as a trampoline which "thrusts" the vehicle into the space between Mars and Jupiter, where the zone of asteroids is situated.

Another flight variant on which specialists are now working is the use, as in the "Vega" project, of one space vehicle for the solution of several independent problems: execution of a flight to Venus and its exploration, followed by return to the earth, and after changing its trajectory of motion, onward to the belt of asteroids.

It is unquestionable that just information on the external form of asteroids will be of great scientific value. The landing of a special probe dispatched from a fly-by module to the asteroid surface would make it possible to collect more information, especially on the chemical and mineralogical composition of the surface material.

It is proposed that the space vehicle will approach the asteroid to a distance of several tens of meters, and controlling its position by means of engines, would fly over it at velocities of 2-5 m/s. At the time of closest approach the probe would be separated and would land. Such a technology can be used without difficulty near cosmic bodies with very low gravitation, to which it would be difficult to be "stuck." The impact at the time of "landing" on the asteroid surface will be soft.

The "Fobos" ["Phobos"] project, planned for the late 1980's, is new in the planetary space research program. This is a complex multipurpose program which includes exploration of plasma and physical fields in interplanetary space on the flight trajectory Earth-Mars, around the sun and in circum-Martian space from the orbit of an artificial satellite, and finally, multisided exploration of its natural satellite Phobos.

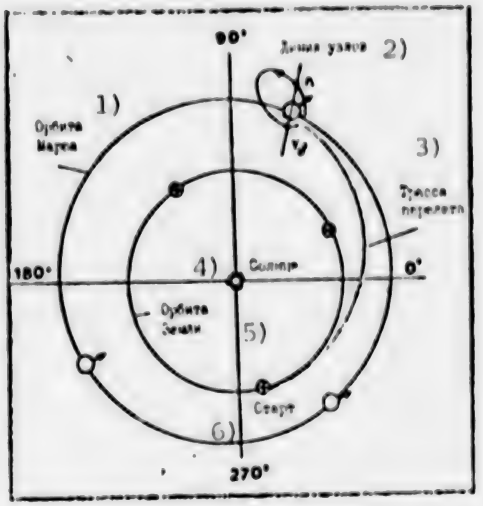

Fig. 1. Diagram of flight of "Phobos" space vehicle on Earth-Mars trajectory. Position of the planets at the time of launching and at the time of approach to Mars. Position of the first orbit near Mars and its line of nodes.

KEY:

1. Martian orbit
2. Line of nodes
3. Flight trajectory
4. Sun
5. Earth's orbit
6. Launching

⊕ – Earth
♂ – Mars
γ_{σ} – point of Martian vernal equinox
☊ – ascending node of first orbit

Indeed, there is no other planet of the solar system linked to such fantastic, daring and beautiful hypotheses. It was not so long ago that earthlings were excited by the possibility of finding beings similar to man on Mars. These expectations were seemingly justified by individual observations.

For example, the greatest sensation was caused by the Martian "canals," a network of regular dark lines discovered by the Italian astronomer Schiaparelli. This name, mechanically adopted from terrestrial reality, instantaneously acquired "citizenship rights." Everyone believed this (because they very much wanted to believe it): the canals were the result of the activity of thinking beings.

The regular spring propagation of a "warming wave" in each hemisphere explained the awakening of vegetation together with an increase in heat and moisture.

The anomaly in the motion of the Martian satellites Phobos and Deinos gave rise to the hypothesis of their possible artificial origin. The author of this hypothesis was the Soviet astronomer I. S. Shklovskiy, corresponding member, USSR Academy of Sciences.

The first direct investigations of the Martian atmosphere were made in 1974 by Soviet automatic stations of the "Mars" series. It was found that the pressure there is 1/200th of the pressure of an air column on the earth. The atmosphere consists almost entirely (95%) CO_2. It was experimentally established that there is no sufficiently strong magnetic field which could safeguard the planetary surface from bombardment by charged particles. All this unquestionably undermined the position of adherents to the idea of a "populated" Mars. However, the problem of life on this planet, in the opinion of some scientists, still remains open. And the American "Vikings," despite the comprehensive nature of the experiments with the landing modules, could not give an unambiguous answer to this.

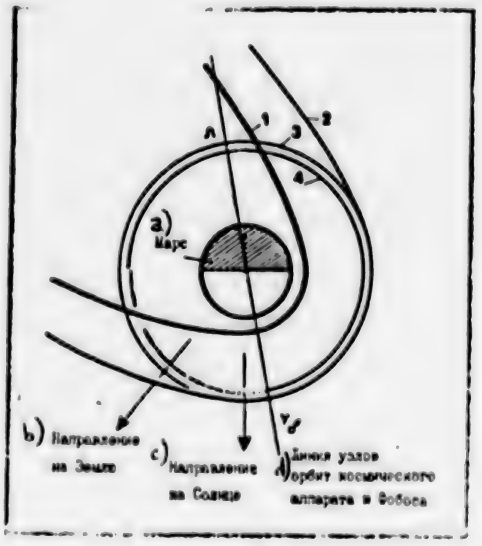

Fig. 2. Orbits of "Phobos" space vehicle. 1, 2, 3 -- around Mars (projections of orbits onto plane of the ecliptic), 4 -- orbit of Phobos.

a) Mars, b)direction to Earth, c) direction to Sun, d) Line of nodes of spacecraft and Phobos orbits

———— Part of orbit of Phobos on which the space vehicle will approach and fly over the Martian satellite.

On many of the photographs taken from aboard space vehicles, on the planetary surface it is possible to see traces of water erosion. Rivers carrying great volumes of water once evidently flowed there. Even now, as indicated by measurements carried out by the Soviet stations "Mars-3" and "Mars-5," the moisture content in individual regions can be rather high. Without question, at times the climate of Mars experiences considerable change. However, it is still not definitely clear what is responsible for these changes.

With respect to Phobos and Deimos, however, the unanswered questions and the problems involved in comprehending their nature are still greater. The first references to the satellites of Mars were made in the famous "Gulliver's Tra els" by the great English satirist Jonathan Swift. On the third journey his hero enters the Land of Laputa. He learned from Laputan astronomers that they "...have discovered two small stars or satellites revolving around Mars, of which the closest to Mars is at a distance from the center of that planet equal to three of its diameters and the more distant body is at a distance of five such diameters from it. The first makes its revolution in 10 hours, whereas the second has a period of 21 1/2 hours."

KEY:

1. Direction to sun
2. Direction to earth
3. Phobos
4. Orbit of Phobos

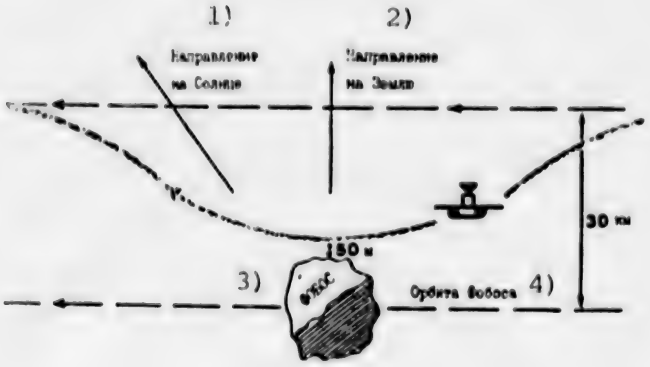

Fig. 3. Diagram of flight of "Fobos" space vehicle over surface. Relative flight velocity 2-5 m/s; flight time at altitude 50 m -- 15-20 minutes.

And only more than 1 1/2 centuries later, in 1877, were the Martian satellites discovered by the American astronomer A. Hall. Their orbital parameters differed little from those predicted by Jonathan Swift.

For a long time it was not possible to determine the mass or size of the satellites. Assuming that their reflectivity is the same as for Mars, an effort was made to evaluate these parameters on the basis of their brightness. Measurements made later from aboard space vehicles indicated that both Phobos and Deimos are twice as large as surmised earlier and their mass is 1 1/2 times less. Accordingly, the Martian satellites cannnot consist of dense rocks remelted by volcanic processes, the rocks making up the crust and mantle of planets of the earth group.

According to one of the hypotheses, both satellites are asteroidal bodies captured by Mars. Due to their small mass, as noted above, they could not experience any geological changes from the time of formation of the solar system (about 4.5 billion years ago). Regolith, the surface layer, was unquestionably subjected to the action of the solar wind and bombardment by meteorites. Therefore, study of the surface of satellites will make it possible to judge not only the conditions for formation of bodies in the solar system, but also their subsequent evolution.

In accordance with "Intercosmos" traditions, the USSR Academy of Sciences invited scientific organizations of other countries to participate in the "Fobos" project. There has been enthusiastic response to this proposal by the scientists of Bulgaria, Hungary, GDR, Poland, Czechoslovakia, Austria, FRG, France, Sweden and also the European Space Agency. The program for the project as a whole has now been agreed upon and the most immediate task of its participants is the development of the scientific instrumentation package. This work is being guided by V. M. Balebanov, deputy director of the Space Research Institute, USSR Academy of Sciences. The development of the unique scientific instruments must be accomplished in a record short time. After all, the launching time is strictly governed by the relative positions of the Earth and Mars.

Two fundamentally new scientific stations will be launched from the Baykonur cosmodrome in mid-1988. First they will enter the orbit of an artificial earth satellite and from there will be directed to Mars. The flight will last 200 days. Upon approaching the planet, the space vehicles will go into a highly elongated elliptical orbit situated over the Martian equator. Then they will pass into circular orbits and finally, into an orbit close to that in which the Martian satellite Phobos moves.

Plans call for the collection of information on the specifics of flow of the solar wind around Mars and the characteristics of its magnetosphere. At the times of closest approach to the planet data will be collected on its atmosphere and surface. The flight program, in particular, provides for the conducting of a television survey with a high resolution. One of the objectives of the radiometric and photometric measurements will be obtaining a temperature map of the surface, study of the diurnal and seasonal dynamics of the temperature regime, determination of the thermal inertia of surface material and search for regions of permafrost, as well as sectors with the release of endogenous (internal) heat.

Determinations of the seasonal, diurnal and local variations of atmospheric characteristics, vertical profiles of its temperature and pressure, and also the vertical distributions of concentrations of ozone, water vapor, molecular oxygen and dust will yield complete information on the photochemical processes transpiring there, which will assist in formulating a reliable model of the planetary atmosphere. It may be that it will be possible to obtain data on the reserves of moisture on Mars, its vertical and horizontal movements. A careful analysis of all these data will make it possible to ascertain the main reasons for the generation of dust storms, the variability of Martian "weather" and climate.

When the space vehicle comes closest to Phobos a very small sector of its surface with an area of only one square millimeter will be "illuminated" by a laser ray. Due to the high accuracy of focusing, guaranteed by the on-board IR range finder, the energy density in the illuminated spot will be very great. A thin layer of regolith, similar in its composition to bed rock, will be explosively evaporated and transformed into plasma. On the basis of the time required for the plasma to travel from the surface to the vehicle a special spectrometer will determine its composition. It is proposed that approximately a million particles will be registered during one cycle. One American planetologist, upon being familiarized with the Soviet proposals, declared that "Even the idea of using such technology is so innovative that it boggles the mind." Another experiment which is to be realized is based on use of a special on-board accelerator of the flux of krypton ions. Each hundredth krypton ion will dislodge one ion of regolith matter. An analysis of these secondary particles will make it possible to study the composition of the uppermost layer of surface material with a thickness of millionths of a millimeter.

The thermophysical and reflective properties of Mars and Phobos will be investigated simultaneously with a combined radiometer, photometer and IR spectrometer. Such a combined approach is a distinctive feature of the planned

experiments. In addition, a global thermal survey of the surface will be made. The data from this survey will become the basis for plotting its temperature map.

A television survey of the surface is also provided for. In addition to being of independent scientific importance, the images will be important for the coordinate referencing of measurements made using other instruments.

Work is being done on the delivery of autonomous landing modules to the surface of Phobos for carrying out research directly at its surface. These may include a television camera for obtaining panoramic images, study of the chemical composition and physical characteristics of surface material and measurement of its temperature. A special radio system carried aboard the autonomous station will ensure implementation of a variety of experiments related to solar system mechanics. As in the "Vega" project, the largest radio telescopes in the world, linked into interferometers with exceptionally long base lines, will receive the signals from the on-board transmitter. In this case the angular resolution will no longer be determined by the diameter of each individual radio telescope, but by the base -- the distance between them. Thus, it is possible to obtain a resolution 1,000 times greater than with the largest optical telescopes. This will ensure reliable tracking of Phobos during its motion in orbit around Mars.

The implementation of the solar research program will begin already on the flight trajectory of the space vehicles toward Mars. As they withdraw from the earth the solar angle between the direction to the vehicle and our planet will increase from 0 degrees to values close to 180°. Using observations of the sun simultaneously from aboard space vehicles, from the earth and circumterrestrial satellites, a unique opportunity will be afforded for retrieving the three-dimensional stereoscopic structure of the solar chromosphere and corona. When space vehicles are put into orbits of artificial satellites of Mars they can be used in observing processes on the sun which are invisible at this time from the earth. All this will make possible a better comprehension of solar activity and a more reliable prediction of manifestations of solar activity.

As is well known, the plans for continuing the "Viking" program discussed by NASA in the United States have not been realized. American scientists planned, in particular, the development of Martian rovers and the use of spacecraft for the return of Martian surface material to the earth (as in the example of the Soviet stations of the "Luna" series).

In 1990 the United States has plans for the launching of a space vehicle to Mars for exploration of the planet from an artificial satellite orbit. In the opinion of leading American scientists, coordination of the program for this flight with the "Fobos" project, which will be implemented two years earlier, would make it possible to achieve the greatest scientific results.

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INTERPLANETARY SCIENCES

SAGDEYEV COMMENTS ON ACHIEVEMENTS OF VENERA-15, 16

Moscow APN: ADVANCES OF SCIENCE AND TECHNOLOGY in English No 9, 5 May 86 pp 1-4

[Article by Academician Roald Sagdeyev, director of USSR Academy of Sciences Institute of Space Research: "Venus Is Revealing Its Secrets"]

[Text] The first major discovery on Venus was made by member of the Russian Academy of Sciences Mikhail Lomonosov who suggested, in 1761, that it had a dense atmosphere. Yet, it was because of the atmosphere, or rather the planet's thick cloud cover, that the Venusian surface remained comparatively little studied for quite a long time. Only in the last few years, due to Soviet efforts, this obstacle was overcome. "Radar Survey of the Surface of Planet Venus From Space Probes Venera-15 and Venera-16," a collective work by a group of Soviet scientists, was awarded a 1986 Lenin prize.

The use of radar methods in ground observations once made it possible to penetrate the cloud cover, estimate reflectivity of the surface, and measure the rotation period. It proved unexpectedly long--243 Earth days. Further progress in the study of Venus came as a consequence of space exploration. Notably, Soviet probes Venera-9 and -10 and Venera-13 and -14, or, rather, their descent capsules, transmitted to the Earth the panoramas of the Venusian surface. The U.S. probe Pioneer-Venus, put in artificial satellite orbit around Venus in 1978, revealed structures of continental magnitude, such as Ishtar Land, Aphrodite Land, and Beta region. Yet its instruments failed to identify smaller geological features, such as mountain ranges, craters, and rift valleys.

The launching of Soviet probes Venera-15 and -16 ushered in a new stage in the exploration of Venus. They were the first to make high-resolution photographs of a large part of the Venusian surface. With the images showing distinctly most geological structures, it became possible to brush aside conjectures and begin a direct study of the planet's surface, its origin and evolution. This stage could be accomplished owing to the unification of radar planetary studies and planetary flights, two high-achievement directions in Soviet science and technology, founded by outstanding Soviet scientists Academicians Mstislav Keldysh, Sergei Korolev, and Vladimir Kotelnikov.

Venera-15 and -16 were equipped with radar systems composed of a side-looking radar with the resolution of close to one kilometer and a radioaltimeter whose measurements helped recreate the surface features. The images were obtained through an extremely complex mathematical process.

Every day, while passing over the planet's northern hemisphere, both probes, launched into polar orbits with a 24-hour revolution period, photographed bands of surface 120 kilometers wide and 7,500 kilometers long. In 24 hours Venus turned a little and, during a next orbit, new bands were photographed, partly overlapping with the previous ones. Information enabling to create a blanket image of the northern hemisphere was accumulated over a full rotation period, that is, eight months of continuous work by the two probes. An interruption in photographing would have entailed gaps in the image. To obviate this, one station was always ready to photograph the area missed by the other.

Information was passed to the Earth through a new communications line which operated over distances of up to 260 million kilometers and ensured a 30-fold increase in transmission speed as compared with the previously used channels. On the Earth, the transmissions were received by two major antennas--one with 70 meter diameter of the main mirror at the Space Communications Center at Yevpatoriya, and the other, with a 64-meter mirror, at Medvezhye Ozera near Moscow. The reliability of the entire system was enhanced by the doubling of reception.

For a number of reasons, the photographing was made by so-called digital methods. We inaugurated a specialized data processing center which could perform nearly 100 million operations a second, something that made it possible to recreate the image concurrently with the experiment. The effort was backed by unique software.

Beginning in October 1983, the survey was successfully accomplished in July 1984. The results surpassed all expectations. For the first time we had a radar image of a vast territory in the northern hemisphere, measuring a total of 115 million square kilometers. All stages in the evolution of the surface over a period of more than one billion years could be easily "read off" this area. It is clear, therefore, why the scientific results of the Soviet space mission, were in the center of attention of planetary scientists and geologists all over the world.

Some time ago the General Assembly of the International Astronomical Union gave names to 260 newly-discovered geological features. By tradition all Venusian features can have only female names (the only exception being a mountain called after British physicist James Maxwell). Added to the planet's map were the names of Yekaterina Dashkova, first president of the Russian Academy of Sciences, the actress Maria Yermolova, and the poetess Anna Akhmatova. There was a motion to perpetuate the memory of U.S. woman astronauts Sharon Christa Mcauliffe and Judith Reznik, who had died in the Challenger disaster together with five male astronauts, by giving their names to features on Venus.

There are few experiments in the history of space exploration that have led to as sharp an increase and qualitative improvement in the body of knowledge about the origins and evolution of the planets of the solar system as the Venera-15 and -16 mission. The results of this epoch-making flight will have the most serious consequences for the Earth sciences--geochemistry and geology--in their study of the Earth's past and, possibly, future.

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CSO: 1852/5

UDC 523.4

FIRST STAGE IN 'VEGA' PROJECT

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86
(manuscript received 11 Sep 85) pp 5-9

[Article by R.Z. Sagdeyev and V.I. Moroz, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] The "Vega-1" and "Vega-2" landers made a soft landing on the Venusian surface in June 1985. During their descent balloons were set free which floated freely in the atmosphere for about 2 days at an altitude of about 54 km. After a fly-by of Venus the interplanetary stations received correcting signals which ensured flight toward Halley's comet. For the first time the balloons made possible direct observation of movement of air masses in the Venusian atmosphere. A detailed study was made of the characteristics of aerosols and the content of trace gases on the nighttime side. Ground composition research was continued. The "Vega" project was carried out under the "Intercosmos" program with significant contributions being made by French scientists. [A diagram shows the principal stages in descent of the landers and activation of the balloon systems. Tables list the scientific experiments carried out on the ground and with the balloon instruments.] Two networks of radio telescopes were organized for determining the trajectories of balloon probes and for around-the-clock reception of scientific data. The Soviet network was coordinated by the USSR Space Research Institute and the international network was coordinated by the French National Space Research Center. Figures 1.

5303/8309
CSO: 1866/90

INTERPLANETARY SCIENCES

UDC 523.4

'VEGA' PROJECT BALLOON EXPERIMENT

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86 (manuscript received 25 Oct 85) pp 10-15

[Article by R.Z. Sagdeyev, R.S. Kremnev, V.M. Linkin, J. Blamont, R. Preston and A.S. Selivanov, Space Research Institute, USSR Academy of Sciences, Moscow; "Intercosmos" Council, USSR Academy of Sciences, Moscow; National Space Research Center, Paris, France; Jet Propulsion Laboratory, Pasadena, United States; State Center for Study of Natural Resources, Moscow]

[Abstract] The "Vega" balloon project marked a fundamentally new stage in study of dynamics of the Venusian atmosphere. The balloons drifted under the influence of the zonal wind and investigated extensive regions. During the period 1974-1980, under a joint program of the USSR "Intercosmos" Council and the French National Space Research Center, Soviet and French specialists designed a balloon station for physical, chemical, and meteorological measurements during flight in the Venusian cloud layer. The French National Space Research Center coordinated work of the international network of radio telescopes and the station itself was constructed in the USSR. The international network was directed by J. Blamont and R. Preston. Signals from balloon stations were received by 6 Soviet and 14 foreign tracking stations. Virtually all the largest radio telescopes in the world participated in the balloon experiment. Telemetric data were received at Yevpatoriya, Ussuriysk, Goldstone, Madrid and Canberra. The total weight of equipment and instruments, together with the balloon station proper, was 120 kg. The two balloon stations were put into the Venusian atmosphere on the nighttime side. The balloons floated in the dense cloud layer within the convective zone at an altitude of 53-54 km. They drifted westward under the influence of the zonal wind. The balloons each functioned for 46 hours. Along the flight trajectory the stations measured temperature, pressure, wind vertical velocity component, backscattering coefficient and other parameters. Mean flight velocity was 66-69 m/s. Balloon instruments operated until storage batteries were exhausted. By end of operation the balloons had descended to an altitude of 500 m. In 4 days the world network of radio telescopes made a total of 1,200 contacts and the total volume of collected data was $\sim 1.5 \cdot 10^{12}$ bit. Figures 3.

5303/8309
CSO: 1866/90

INTERPLANETARY SCIENCES

UDC 523.4 + 520.8

'VEGA' PROJECT BALLOON EXPERIMENT, SURFACE COMPLEX

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86
(manuscript received 25 Oct 85) pp 16-18

[Article by R.Z. Sagdeyev, L.I. Matveyenko, V.M. Linkin and V.V. Kerzhanovich, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] The proposal to carry out the "Vega" balloon experiment for studying the dynamics of the Venusian atmosphere was made in April 1974. It was proposed that observations be made by the very long baseline interferometry method. Such a network was organized by integrating the radio telescopes at Yevpatoriya, Ussuriysk, Medvezhiye Ozera, Simeiz, Ulan-Ude and Pushchino. This network was supplemented by stations at Goldstone, Madrid and Canberra, thereby bringing virtually all the major radio telescopes of the world into a unified radio-interferometric network. The international network was coordinated by the French National Space Research Center. The selected wavelength of 18 cm was virtually free of industrial interference, influenced little by the ionosphere and interplanetary medium. At this wavelength there are powerful sources of maser radiation emitting narrow hydroxyl lines, making it possible to adjust and check the system. At most stations a system of the MARK-2 type was used. Specialized "Vega" reception and registry apparatus was installed at a number of Soviet stations for increasing reliability of signal registry and reducing losses during digital processing of weak monochromatic signals. References 7: 6 Russian, 1 Western.

5303/8309
CSO: 1866/90

UDC 523.4 + 520.6

'VEGA' BALLOON STATION AS MEANS FOR STUDYING DYNAMICS OF VENUSIAN ATMOSPHERE

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86 (manuscript received 25 Oct 85) pp 19-24

[Article by R.S. Kremnev, A.S. Selivanov, V.M. Linkin, J. Blamont, R.V. Bakitko, A.N. Lipatov, I.Ya. Tarnoruder, V.I. Puchkov, V.D. Kustodiyev, A.A. Shurupov, S.P. Ignatova, V.V. Kerzhanovich, L.I. Khlyustova, G.A. Frank, A.I. Turkova, V.P. Karyagin, A.V. Kostin, V.I. Mashkov, K.M. Pichkhadze, A.V. Terterashvili, C. Malique, B. Ragent and R. Preston, Space Research Institute, USSR Academy of Sciences, Moscow; "Intercosmos" Council, USSR Academy of Sciences; State Center for Study of Natural Resources, Moscow; Radio Engineering and Electronics Institute, USSR Academy of Sciences, Moscow; National Space Research Center, Paris, France; Aeronomy Service, Verriere, France; Ames Research Center, Moffett Field, United States; Jet Propulsion Laboratory, Pasadena, United States]

[Abstract] The "Vega" balloon is a spherical envelope fabricated of teflon fabric to which a teflon film is applied. The envelope, filled with helium to a pressure of 30 mbar, has a diameter of 3.4 m. The balloon station weighs 21 kg (12.5 kg--envelope and connections, 2.5 kg--helium, 6.5 kg--instrument gondola). The balloon floated at 53-54 km. Envelope volume was 19.6 m^3 at zero excess pressure. The rate of helium diffusion through the envelope was very slow. The gondola was suspended to the balloon on 13 lines. The upper part of the gondola was a conical spiral antenna with a diameter of 14 cm. Beneath it, also on lines, were two other sections--transmitter, time-programming unit, master oscillator and "Meteo" meteorological instrument package. The "Meteo" complex included a telemetric system, sensors for pressure and illumination and an extensible shaft on which there were temperature and vertical wind velocity sensors. The transmitter operated in two regimes: transmission of telemetric data and regime of coordinate measurements. The pressure, temperature and vertical velocity sensors and nephelometer were interrogated each 75 s; the illumination sensor was interrogated each 10 s. Signals from the "Vega" flyby vehicle were transmitted simultaneously with signals from the balloon station (required for correcting the influence of the interplanetary medium, ionosphere and atmosphere). Transmitter output power was about 4.5 W. During movement of the station the effective radiated power varied from 2 to 4.5 W due to variation of the angle between the local vertical, balloon antenna and direction to the earth. The balloon envelope was radiotransparent. Various aspects of data processing and transmission are described. Figures 2.

5303/8309
CSO: 1866/90

UDC 523.4 + 520.8

'VEGA' PROJECT BALLOON EXPERIMENT: GLOBAL NETWORK OF RADIO TELESCOPES AND FIRST RESULTS

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86 (manuscript received 25 Oct 85) pp 25-29

[Article by R. Preston, R.Z. Sagdeyev, J. Blamont, L.I. Matveyenko, V.M. Linkin, V.V. Kerzhanovich, A.B. Severnyy, G. Laurans, C. Hildebrand, G. Purcell, S. Finley, Ch. Stelzried, J. Ellis, G. Petit, L. Boloh, A. Ortega-Molina, L. Rosolen, A. Boichat, F. Biraud and D. Collin, Jet Propulsion Laboratory, Pasadena, United States; Space Research Institute, USSR Academy of Sciences, Moscow; National Space Research Center, Paris, France; Meudon Observatory, Meudon, France; Crimean Astrophysical Observatory, USSR Academy of Sciences, Nauchnyy village]

[Abstract] The "Vega" balloons made it possible to carry out studies of dynamics of the Venusian cloud layer. Data obtained using a terrestrial network of radio telescopes provided details on the mean zonal flow, macroscale vortical movements, wave processes, turbulence, transfer of heat and momentum and meridional movements. At present Doppler measurements have been processed; radiointerferometer data require much more processing. The main stations in the network were Yevpatoriya, Ussuriysk, Goldstone, Madrid and Canberra. A signal had to be received at one of these main stations (a map shows the location of all 20 stations in the network and a table lists them by name and antenna diameter]. It was anticipated that the rms errors in determining balloon coordinates and velocities would be 15 km and 1 m/s respectively. In overlapping intervals measurements from different stations coincide with an accuracy better than 1 Hz. On the basis of such data and a model of purely zonal movement the mean wind velocity was estimated at 69 ± 1 m/s for the "Vega-1" and 66 ± 1 m/s for the "Vega-2." It was also possible to evaluate the balloon trajectories and obtain data on small-scale atmospheric turbulence. Figures 2; references 7: 4 Russian, 3 Western.

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INTERPLANETARY SCIENCES

UDC 523.4

METEOROLOGICAL MEASUREMENTS OF 'VEGA-1' AND 'VEGA-2' BALLOON STATIONS. SECTION ALONG DRIFT TRAJECTORIES

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86 (manuscript received 25 Oct 85) pp 30-35

[Article by R.Z. Sagdeyev, V.M. Linkin, J. Blamont, R. Preston, V.V. Kerzhanovich, A.N. Lipatov, A.A. Shurpov, E. Ingersoll, D. Crisp, A.V. Terterashvili, N.A. Armand, R.V. Bakitko, A.S. Selivanov, B. Ragent, C. Malique, A. Seiff, Yu. N. Aleksandrov, L. Elson, J. Urech, J. Morales and R. Young, Space Research Institute, USSR Academy of Sciences, Moscow; National Space Research Center, Paris, France; Jet Propulsion Laboratory, Pasadena, United States; Radio Engineering and Electronics Center, USSR Academy of Sciences, Moscow; Ames Research Center, Moffett Field, United States]

[Abstract] The "Vega-1" and "Vega-2" balloon stations during flight in the Venusian atmosphere measured ambient temperature and pressure, vertical component of wind velocity, backscattering coefficient in cloud layer, mean illumination level, number of light bursts and times of their appearance. The Doppler shift of signals from the balloons were used in determining the zonal component of wind velocity. All these parameters were measured for the 46 hours of flight of each balloon during its westerly drift under the influence of the wind. During the 46 hours of drift each balloon station transmitted telemetric data collected in 1.5-hour or 30-minute intervals (total duration of transmission--22 hours 30 minutes). There was a high degree of correlation between variations of temperature and pressure. During flight both balloon stations experienced a great number of deviations in altitude from the equilibrium altitude; these were attributable to vertical movements in the atmosphere. The amplitude of vertical movements and their velocity were considerably greater than expected. Both stations carried a backscattering nephelometer for analyzing variations in cloud layer density. No regions of strong clearing were discovered, ahthough there were density variations of great time scales which correlated with descending flows and a temperature increase. Fine structure of the cloud layer was measured (variations of 20 percent from the mean level). Figures 2; references 2: 1 Russian, 1 Western.

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UDC 523.4

THERMAL STRUCTURE OF MIDDLE CLOUD LAYER IN VENUSIAN ATMOSPHERE

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86 (manuscript received 25 Oct 85) pp 36-40

[Article by V.M. Linkin, J. Blamont, A.N. Lipatov, A.A. Shurupov, C. Malique, S.P. Ignatova, G.A. Frank, L. I. Khlyustova, A.V. Terterashvili, A. Seiff, V.V. Kerzhanovich, B. Ragent, R. Young, L. Elson, R. Preston, E.Ingersoll and D. Crisp, Space Research Institute, USSR Academy of Sciences, Moscow; National Space Research Center, Paris, France; Ames Research Center, Moffett Field, United States; Jet Propulsion Laboratory, United States; California Institute of Technology, United States]

[Abstract] PT data obtained by the two "Vega" balloon stations reveal a strong correlation between temperature and pressure. However, expressed in PT coordinates, the data for the two stations are approximately 6.5 K different from one another, despite identical pressures. This difference was surprising because the points of entry of the balloon stations were symmetric relative to the equator. This suggests that the balloon stations during flight were in air masses having different thermal characteristics and each station remained in the same air mass most of the time while drifting 1/3 of the circumference of the planet. The measured temperatures for the most part vary linearly with pressure. The atmosphere is close to adiabatic. The 6.5 K difference persisted in the longitude range from 180 to 70°. The finding that the Venusian atmosphere is close to adiabatic is consistent with earlier observations. Some small deviations suggest the existence of individual small air masses. Figures 3; references 4: 2 Russian, 2 Western.

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CSO: 1866/90

INTERPLANETARY SCIENCES

UDC 523.4

'VEGA' PROJECT BALLOON EXPERIMENT: MEAN WIND VELOCITY IN VENUSIAN ATMOSPHERE ACCORDING TO DOPPLER MEASUREMENTS BY BALLOON STATIONS

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86 (manuscript received 25 Oct 85) pp 41-45

[Article by R.A. Andreyev, V.I. Altunin, N.A. Armand, E.L. Akim, R.V. Bakitko, J. Blamont, L. Bolon, A.S. Vyshlov, Yu.N. Gorshenkov, N.M. Ivanov, V.V. Kerzhanovich, V.I. Kostenko, L.R. Kogan, V.D. Kustodiyev, V.M. Linkin, G. Laurans, L.I. Matveyenko, Ye.P. Molotov, J. Morales, R. Preston, G. Petit, S.V. Pogrebenko, V.I. Puchkov, A.S. Selivanov, Ch. Stelzried, I.Ya. Tarnoruder, V.F. Tikhonov and C. Hildebrand, Space Research Center, USSR Academy of Sciences; Radio Engineering and Electronics Institute, USSR Academy of Sciences, Moscow; State Center for Study of Natural Resources, Moscow; National Space Research Center, Paris, France; Jet Propulsion Laboratory, Pasadena, United States]

[Abstract] The "Vega" balloon soundings of the Venusian atmosphere yielded new data on diurnal-longitudinal variation of wind velocity. Wind velocity was determined from changes in the trajectory of the balloon, which moved together with the wind. Data from Doppler measurements of frequency of the signal from balloons were used for a preliminary estimate of mean zonal circulation and small-scale turbulence. Both balloons were injected near the equator so that the Doppler measurements were sensitive primarily to the zonal component of wind velocity. A very simple model of purely zonal movement at constant velocity was used in estimating wind velocity. The determined wind velocities of 69 ± 1 m/s for "Vega-1" and 66 ± 1 m/s for "Vega-2" in the first approximation made it possible to evaluate the balloon trajectories. Trajectory data are given in a table. The estimates of mean wind velocity exceeded by 5-10 m/s the values obtained for this altitude obtained in earlier experiments, suggesting a real temporal variability of circulation. Figures 2; references 8: 4 Russian, 4 Western.

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UDC 523.4

'VEGA' PROJECT BALLOON EXPERIMENT: SMALL-SCALE TURBULENCE IN MIDDLE CLOUD LAYER OF VENUS

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86 (manuscript received 25 Oct 85) pp 46-51

[Article by V.V. Kerzhanovich, Yu. N. Aleksandrov, R.A. Andreyev, N.A. Armand, R.V. Bakitko, J. Blamont, L. Boloh, V.A. Vorontsov, A.S. Vyshlov, S.P. Ignatov, E. Ingersoll, A.L. Zaytsev, V.P. Lysov, B.I. Mottsulev, K.M. Pichkhadze, R. Preston, C. Hildebrand, G. Petit and R. Young, Space Research Institute, USSR Academy of Sciences, Moscow; Radio Engineering and Electronics Institute; USSR Academy of Sciences, Moscow; National Space Research Center, Paris, France; Jet Propulsion Laboratory, Pasadena, United States]

[Abstract] Doppler data for the "Vega" balloon probes of the Venusian atmosphere yielded new data on turbulence in the middle cloud layer. The Doppler measurements with a time discreteness of 0.5 s were processed from records registered at Yevpatoriya. There were 62 intervals each with a length of 332 s. All velocity variations with periods greater than approximately 30 s were interpreted as manifestations of atmospheric turbulence. Dynamic activity in the Venusian atmosphere was considerably stronger and more variable than surmised earlier. The most important variations had a time scale of 60-130 s. Turbulence exhibited strong and irregular changes. The amplitude of velocity variations varied from 0.05 to 1 m/s for "Vega-2" and even 2 m/s for "Vega-1." The transition from calm to turbulent sectors can occur rapidly and irregularly. The probability of the presence of turbulence is more than 50 percent--greater than in the earth's atmosphere. There can be close regions in the atmosphere with different properties. The presence of different kinds of air masses on Venus is postulated. It is suggested that in passage over the Aphrodite mountain mass the "Vega-2" balloon encountered terrain-induced thermal convection and therefore greater vertical movements. Figures 3; references 9: 4 Russian, 5 Western.

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INTERPLANETARY SCIENCES

UDC 523.4

'VEGA' PROJECT BALLOON EXPERIMENT: PRELIMINARY ANALYSIS OF RESULTS OF MEASUREMENTS IN APPLICATION TO DYNAMICS OF VENUSIAN ATMOSPHERE

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86 (manuscript received 25 Oct 85) pp 52-58

[Article by J. Blamont, R.Z. Sagdeyev, V.M. Linkin, G.S. Golitsyn, V.N. Ivanov, E. Ingersoll, V.V. Kerzhanovich, D. Crisp, R. Preston, B. Ragent, A. Seiff, L. Elson and R. Young, National Space Research Center, Paris, France; Space Research Institute, USSR Academy of Sciences, Moscow; Atmospheric Physics Institute, USSR Academy of Sciences, Moscow; Experimental Meteorology Institute, Obninsk; California Institute of Technology, Los Angeles, United States; Jet Propulsion Laboratory, Pasadena, United States; Ames Research Center, Moffett Field, United States]

[Abstract] The objective of the "Vega" project was study of the Venusian atmosphere, including characteristics of horizontal and vertical winds and parameters of the cloud layer with emphasis on dynamic processes. There was a difference of ~6.5 K between potential temperatures measured by the "Vega-1" and "Vega-2" which persisted along their entire flight trajectory, indicative that the balloons remained in the same air masses during their individual drifts. Between the northern and southern hemispheres there may be a significant asymmetry already noticeable with a latitude difference ~14° or there may be time or longitude changes in atmospheric structure. The 6.5 K difference is too great to be attributable to turbulent mixing in the convective layer; macroscale processes are therefore probably responsible. Doppler measurements indicated that the balloons probably registered a disturbance associated with the sun or a planet, such as a solar thermal tide. Temporal changes in vertical winds were observed. During the entire flight of the "Vega-1" periods of strong descending currents were registered. These strong descending movements could be seen clearly in PT measurements. Certain changes in "Vega-2" data may be attributable to the influence of topography. Figures 1; references 14: 5 Russian, 9 Western.

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INTERPLANETARY SCIENCES

UDC 520.27 + 521.9

SOVIET VERY LONG BASELINE INTERFEROMETRY NETWORK AT FREQUENCY 18 CM

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12, No 1, Jan 86 (manuscript received 19 Sep 85) pp 59-65

[Article by L.I. Matveyenko, R.Z. Sagdeyev, V.M. Balebanov, V.I. Shevchenko, V.I. Kostenko, V.A. Grishmanovskiy, V.Ye. Velikhov, S.P. Ignatov, B.Z. Kanevskiy, L.R. Kogan, A.N. Kozlov, G.D. Kopelyanskiy, A.P. Molodyanu, Ye.P. Molotov, A. Kh. Papatsenko, A.M. Romanov, I.A. Strukov, V.V. Timofeyev, A.V. Shevchenko, A.B. Severnyy, I.G. Moiseyev, R.L. Sorochenko, A.P. Tsivilev, R.M. Martirosyan, A.M. Aslanyan, A.G. Gulyan, Ya.S. Yatskiv and M.V. Golovnya, Space Research Institute, USSR Academy of Sciences, Moscow; Crimean Astrophysical Observatory, USSR Academy of Sciences, Nauchnyy village; Physics Institute imeni P.N. Lebedev, USSR Academy of Sciences, Moscow; Radio Physics and Electronics Institute, Armenian Academy of Sciences, Yerevan; Main Astronomical Observatory, Ukrainian Academy of Sciences, Goloseyevo]

[Abstract] The Soviet very long baseline radio interferometer system operates at a wavelength of 18 cm and during implementation of the "Vega" project was used in determining the trajectory of movement of the balloons and the flyby vehicle. A global interferometry system was coordinated with the Soviet system during these observations, ensuring around-the-clock observations with a high accuracy. Strong narrow maser lines were used in preliminary adjustment of the network, in determining the relative position of the elements and synchronization of atomic clocks; quasars were used in more precise determination of these parameters. In the Soviet network use was made of the large fully rotatable parabolic antennas near Simeiz, Yevpatoriya, Pushchino, Ulan-Ude and Ussurivsk. In this system the maximum spacing in an east-west direction is 7,000 km; the maximum spacing in a north-south direction is 1,300 km. The widths of the interference lobes fall in the range 0".006 to 0".4. An advantage of the network is that the most sensitive components are at a maximum distance from one another. Figures 3; references: 5 Russian.

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UDC 523.4

RESEARCH ON COMPOSITION OF VENUSIAN ROCK IN NORTHERN PART OF APHRODITE LAND ON LANDER OF 'VEGA-2' AUTOMATIC INTERPLANETARY STATION

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86 (manuscript received 15 Jul 85) pp 66-72

[Article by Yu.A. Surkov, L.P. Moskaleva, O.P. Shcheglov, A.D. Dudin, V.P. Kharyukova, O.S. Manvelyan and G.G. Smirnov, Geochemistry and Analytical Chemistry Institute, USSR Academy of Sciences, Moscow]

[Abstract] An experiment was carried out on the "Vega-2" lander for determining the elemental composition of Venusian rocks. The X-ray radiometric method was used in determining the contents of rock-forming elements from Mg to Fe and some heavier rare elements using apparatus installed on the lander. The method used was the same as employed earlier on Mars and Venus. An improved X-ray fluorescence spectrometer was employed: it consisted of a detection unit and a multichannel pulse analyzer situated within a pressurized, thermostated compartment. [A block diagram of the detection unit is given with eight components identified.] When using all four counters in the instrument it is possible to register elements from magnesium to bromine and from gold to bismuth. The instrument complex was activated at an altitude of about 23 km above the surface. During the first 172 seconds after the landing a ground sample was taken by drilling and a ground sampler. The gas atmosphere around the sample was eliminated. The sample was taken into the lander through a special lock. Chemical composition of the rock was determined. It was found that the greatest correspondence was with rocks in the earth's crust of the troctolite-anorthosite type. In the northern part of Aphrodite Land there are rocks closest to the anorthosite-norite-troctolite (ANT) type occurring widely on the lunar surface. Data have become available on the types of magmatic rocks in the main geomorphological provinces of Venus corresponding to different tectonic and magmatic stages in its development. These include hilly highlands made up of weakly differentiated alkaline basalts; smooth lowlands covered with a volcanic tuff of tholeiitic basalts, "recent" shield volcanic structures also close in composition to tholeiitic basalts and high-mountain masses close in composition to rocks of the ANT group. Figures 3; references 9: 7 Russian, 2 Western.

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CSO: 1866/90

UDC 523.4

WATER VAPOR CONTENT IN VENUSIAN ATMOSPHERE ACCORDING TO DATA FROM 'VEGA-1' AND 'VEGA-2' AUTOMATIC INTERPLANETARY STATIONS

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86 (manuscript received 15 Jul 85) pp 73-77

[Article by Yu.A. Surkov, O.P. Shcheglov, M.L. Ryvkin, N.A. Davydov, D.M. Sheynin and D.Ye. Zhitnikov, Geochemistry and Analytical Chemistry Institute imeni V.I. Vernadskiy, USSR Academy of Sciences, Moscow]

[Abstract] The "Vega-1" and "Vega-2" landers carried VM-4 humidity analyzers for investigating the vertical profile of the distribution of water vapor in the cloud layer and in the troposphere beneath the clouds. Two methods for measuring humidity were used. The VM-4 has coulometric and thermoelectrolytic humidity sensors. In the initial descent segment (altitude 60-50 km) the postulated water vapor concentration was less than the response threshold of a thermoelectrolytic sensor and therefore a coulometric sensor was employed. The range of measurement of absolute humidity with the thermoelectrolytic sensor is 0.38-31.8 mm Hg (corresponding to a dew point temperature -30° to 30°C, whereas the range for the coulometric sensor is 0.01-0.2 percent by volume). The VM-4 was triggered at about 62 km and data were transmitted from that point at a frequency of 2.3 Hz. Two vertical water vapor distribution profiles were obtained for the nighttime side in the altitude range from 60 to 25-30 km (the distance between the landing points was 1,500 km). A diagram of the VM-4 instrument is shown; 14 elements are identified; the diagram serves as a basis for the textual description of the instrument. Figures 2; references 5: 4 Russian, 1 Western.

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CSO: 1866/90

UDC 523.4

STUDY OF ABSORPTION OF ULTRAVIOLET RADIATION IN VENUSIAN ATMOSPHERE BY ACTIVE SPECTROMETRY METHOD

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86 (manuscript received 11 Sep 85) pp 78-84

[Article by J.-L. Bertaux, A.P. Ekonomov, B. Mege, V.I. Moroz, V.I. Gnedykh, A.V. Grigoryev, A. Abergel, A. Houchecorne, J.-P. Pommereau, P. Rigaud, B.Ye. Moshkin and S.B. Sergeyeva, Space Research Institute, USSR Academy of Sciences, Moscow; Aeronomy Service, National Scientific Research Committee, France]

[Abstract] The landing sites of the "Vega-1" and "Vega-2" landers were on the nighttime side of Venus. In spectrophotometric sounding it was therefore proposed that the "active spectrometry" method be used. The spectrometer used had an artificial light source and an optical system sending a light beam through atmospheric gas. The selected range was 2300-4000 A. The two vehicles carried identical ISAV UV spectrometers. One full spectrum consists of 512 elements in the range 0.2-0.4 μm; it was accumulated in the instrument memory in 60 s at altitudes greater than 25 km. The instrument was activated when the lander entered the atmosphere and functioned during its entire descent. Data were transmitted to earth in compressed form. Each landing vehicle registered 30 spectra with total resolution and 450 with low resolution. The experiment was planned on the assumption that SO_2 is the most important absorbing gas. However, the experimental data did not entirely confirm this. A band is present in the spectrum which corresponds to some other gas. Sulfuric acid vapor could make only a small contribution to the observed absorption. It is postulated that the principal absorbent is gaseous sulfur S_8 with a mixing ratio 5-25 ppm at altitudes 25-50 km. Figures 3; references 12: 7 Russian, 5 Western.

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UDC 528.4

PRELIMINARY RESULTS OF OPTICAL RESEARCH ON AEROSOL MEDIUM IN VENUSIAN ATMOSPHERE AT ALTITUDES 30-60 KM USING 'VEGA-1' AND 'VEGA-2'

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 1, Jan 86 (manuscript received 11 Sep 85) pp 85-93

[Article by B.Ye. Moshkin, V.I. Moroz, V.I. Gnedykh, A.V. Grigoryev, L.V. Zasova and A.P. Ekonomov, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] The "Vega-1" and "Vega-2" landers carried identical ISAV-A instruments for analysis of aerosols in Venusian clouds: particle concentration, particle-size distribution, particle shape, refractive index, backscattering coefficient. The ISAV-A consists of a photoelectric aerosol spectrometer and a backscattering sensor. The aerosol spectrometer measured the light fluxes scattered in four directions by individual aerosol particles passing through the instrument. The backscattering sensor measured the light scattered by some region of the aerosol medium near the instrument and/or atmospheric glow. (A block diagram of the ISAV-A accompanies the text.) The instruments functioned normally from an altitude of 63 km to 30-32 km (20 and 18 minutes respectively), during which 43 and 38 particle-size spectra were transmitted, as well as scattering indicatrices for about 5,000 particles. It was found that there is a three-layer main cloud cover, an intermediate zone and a haze layer beneath the clouds with lower boundaries at altitudes 45-48, 42-25 and 32-35 km. The concentration of particles with diameters in the range 0.7-10 μm above 45 km and the relative content of larger particles were lower than observed by "Pioneer" instruments. Particles with a diameter 1 μm were spherical. A nighttime glow was observed in the Venusian troposphere at a wavelength of about 1 μm (its source is probably the hot planetary surface). The backscattering and extinction coefficients varied little in the altitude range from 63 to 32 km. Over the landing points there was a great concentration of submicron particles. Figures 4; references 11: 7 Russian, 4 Western.

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INTERPLANETARY SCIENCES

UDC 523.4

VERTICAL THERMAL STRUCTURE OF VENUSIAN ATMOSPHERE ACCORDING TO TEMPERATURE AND PRESSURE MEASUREMENTS MADE BY 'VEGA-2' LANDER. PRELIMINARY RESULTS

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 2, Feb 86 (manuscript received 25 Oct 85) pp 100-105

[Article by V.M. Linkin, J. Blamont, A.N. Lipatov, S.I. Devyatkin, A.V. Dyachkov, S.P. Ignatova, V.V. Kerzhanovich, C. Malique, B.I. Stadnyk, Ya.V. Sanotskiy, P.G. Stolyarchuk, A.V. Terterashvila, A.A. Shurupov and L.I. Khlyustova, Space Research Institute, USSR Academy of Sciences, Moscow; National Space Research Institute, Paris, France; Lvov Polytechnic Institute; Aeronomy Service, Verriere, France]

[Abstract] The main thermodynamic parameters of the Venusian atmosphere were measured by instruments on the "Vega-2" lander (temperature sensors T1 and T2, pressure sensors P1, P2, P3, part of the "Mateo" instrument package). The temperature sensors were platinum resistance thermometers; the measurement range was from 200 to 800 K and the measurement error was ± 0.5 K. The P1, P2 sensors measured pressure in descent segments important with respect to atmospheric structure; the P3 sensor was for measurements in the lower descent segment. The measurement range for the three sensors was 0-2, 0-20 and 2-110 bar. Surface temperature was 733 ± 1 K and surface pressure was 89.3 ± 1.0 bar. The elevation of the landing point was found to be 500 m. The vertical temperature profile reveals several layers with different static stability. The boundaries between them were at about 8, 38, 45, 56 and 62 km. A near-adiabatic temperature change (neutral stratification) is observed between 45 and 56 km and for the first time up to 8 km. In other regions the temperature gradient is less than adiabatic and stratification is stable. Figures 3; references: 2 Western.

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INTERPLANETARY SCIENCES

UDC 523.6

CHEMICAL ANALYSIS OF AEROSOL IN REACTIONARY GAS CHROMATOGRAPHY ON LANDERS OR 'VEGA' AUTOMATIC INTERPLANETARY STATIONS

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 2, Feb 86 (manuscript received 27 Sep 85) pp 106-109

[Article by B.G. Gelman, Yu.V. Drozdov, V.V. Melnikov (deceased), V.A. Rotin, V.I. Khokhlov, V.B. Bondarev, G.F. Dolnikov, A.V. Dyachkov, D.F. Penarokov, L.M. Mukhin, N.V. Porshnev and A.A. Fursov, All-Union Chromatography Scientific Research Institute, Moscow; Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] In previous research with interplanetary stations there was no analysis of the chemical composition of cloud layer particles by means of gas chromatography methods; it was assumed that such particles for the most part correspond to sulfuric acid droplets with a 75 percent concentration of acid in water. The "Sigma-3" chromatographic data measurement apparatus was developed to fill this gap. The gas chromatography program was directed to study of the chemical composition of aerosol, increasing the number of detectable components and enhancing response level. The analytical part of the instrument included universal detectors (helium detector and katharometer) and selective (electron capture) detectors. The katharometer was used for the first time in a Soviet chromatograph for increasing the dynamic measurement range. Thermoreaction elements were covered by a carbon filter glass filter. It was found that by means of preliminary accumulation of H_2SO_4 on such filters, with subsequent conducting of the reaction at increased temperatures, quantitative measurements can be made at the level 10^{-3}g with an error of about 10 percent. Sulfur dioxide was identified in a gas sample of the atmosphere taken at an altitude of 48 km. There is evidence that the cloud cover may consist of particles of a more complex composition than an aqueous solution of sulfuric acid. Figures 1; references 9: 5 Russian, 4 Western.

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UDC 523.4

MEASUREMENT OF COMPOSITION OF AEROSOL COMPONENT OF VENUSIAN ATMOSPHERE BY 'VEGA-1' AUTOMATIC INTERPLANETARY STATION. PRELIMINARY RESULTS

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 2, Feb 86 (manuscript received 3 Oct 85) pp 110-113

[Article by Yu.A. Surkov, V.F. Ivanova, A.N. Pudov, V.P. Volkov, E.P. Shcretov, B.I. Kolotilin, M.P. Safonov, R. Thomas, J. Lespagnol, A. Hauser, G. Israel, D. Imbault and D. Caramelle, Geochemistry and Analytical Chemistry Institute imeni V.I. Vernadskiy, USSR Academy of Sciences, Moscow; Ryazan Radio Engineering Institute; CNRS, Laboratory for Physics and Chemistry of Environment, France; CNRS, Aeronomy Service, France; CEN, Laboratory for Protection Against Nuclear Radiations, France]

[Abstract] The "Vega-1" vehicle carried instrumentation for determining the chemical composition of cloud particles in the Venusian atmosphere. This instrumentation collected the aerosol, separated particles by mass, carried out pyrolysis and made a mass-spectrum analysis of each discriminated fraction separately. There was inertial separation of particles into two fractions: light and heavy. The boundary of separation was r = 1.5 μm. The two groups of particles were trapped on separate filters. The pyrolytic products were fed into a mass analyzer. In the analysis of the mass spectra for the upper cloud layer level at 62-54 km there was a peak at 64 amu attributable to the presence of sulfur dioxide in the pyrolytic products. The relative value of the SO_2^+/CO_2^+ peak is $(3\text{-}4)\cdot10^{-3}$. The lower limit of the H_2SO_4 content in aerosol is 2.0 mg/m^3. The spectrum also contains the lines 35 and 37 amu belonging to chlorine. The peak of the main isotope ^{35}Cl is $(0.8\text{-}7.0)\cdot10^{-3}$ and for the isotope ^{37}Cl is $3\cdot10^{-4}$, which corresponds to the lower limit of chlorine content. The predominant component of heavy cloud particles is sulfur. It was postulated that this may be present in the form of a liquid aerosol of H_2SO_4 or other condensate which decomposes during heating with the release of sulfur dioxide. References 11: 3 Russian, 8 Western.

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INTERPLANETARY SCIENCES

UDC 523.4

URANIUM, THORIUM AND POTASSIUM CONTENT IN VENUSIAN ROCKS IN LANDING REGIONS OF 'VEGA-1' AND 'VEGA-2' AUTOMATIC INTERPLANETARY STATIONS

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 2, Feb 86 (manuscript received 13 Sep 85) pp 114-119

[Article by Yu.A. Surkov, F.F. Kirnozov, O.P. Soborpov, V.N. Glazov, A.G. Dunchenko and L.P. Tatsiy, Geochemistry and Analytical Chemistry Institute imeni V.I. Vernadskiy, USSR Academy of Sciences, Moscow]

[Abstract] The gamma spectrometers carried on the "Vega" landers were used in determining the content of radioactive elements (uranium, thorium, potassium) in Venusian surface rocks. The gamma spectrometer consisted of a detection block and a block for the processing and output of data. These are situated within a pressurized and thermostated compartment. The spectrometers were triggered at 25 km and operated cyclically during the lifetime of the stations. In the 200-s cycle data were collected for 190 s and 10 s was allocated to data output. "Vega-1" yielded nine spectra before landing and eight thereafter; "Vega-2" yielded ten before landing and nine thereafter. Tabulated data revealed that at both points of "Vega" landing there were rocks with quite close and relatively low contents of natural radioactive elements. Applying the petrochemical classification of magmatic rocks and the established dependence between the class of rocks and their content of natural radioactive elements it can be postulated that with respect to chemical composition the analyzed rocks correspond to basic rocks such as tholeiitic basalts and gabbroids. Figures 5; references: 3 Russian.

5303/8309
CSO: 1866/92

INTERPLANETARY SCIENCES

UDC 523.4

PRELIMINARY RESULTS OF DETERMINATIONS OF CONTENT OF CHEMICAL ELEMENTS IN AEROSOL OF VENUSIAN CLOUDS

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 2, Feb 86 (manuscript received 26 Sep 85) pp 120-122

[Article by B.M. Andreychikov, L.I. Mukhin, B.N. Korchuganov, I.F. Akhmetshin, Ye.N. Tokarev, A.V. Medvedev, M.N. Goldfeld, V.M. Fayboym, A.V. Kalyuzhnyy, I.V. Petryanov and B.I. Ogorodnikov, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] X-ray radiometric instruments were carried on the two "Vega" landers for determining the concentration of chemical elements in the aerosol of Venusian clouds. In this analytical method the structure and properties of the sample remain unchanged. The characteristic x-radiation is transformed into a voltage pulse proportional to the energy of an X-ray photon. The number of pulses of a definite amplitude characterizes the concentration of the corresponding chemical element. The ionization of atoms was accomplished using isotopic X-radiation sources. The measurements were made continuously during descent of the lander in the altitude range 63-47 km. The aerosol was precipitated and simultaneously analyzed on a special filter which was 100 percent effective in retaining particles with a diameter greater than 1 μm. There were four spectrometric channels for continuous analysis of the matter precipitated on the filter. The presence and variations of X-radiation in the field of characteristic energies of Cl, S and P were registered. It was found that sulfur is present in the altitude range 63-47 km and its mean content is 5.8 mg/m^3; chlorine is present in the altitude range 61-52 km in a quantity 4.1 mg/m^3. The measurements in the altitude range 52-47 km can be explained if the aerosol contains phosphorus with a mean concentration 7.7 mg/m^3. Significant variations in the content of sulfur, chlorine and phosphorous were discovered which may be associated with phase transitions or differentiations of these elements in the cloud aerosol. References: 1 Russian.

5303/8309
CSO: 1866/92

INTERPLANETARY SCIENCES

UDC 523.4

PRELIMINARY RESULTS OF MEASUREMENT OF PARTICLE CONCENTRATIONS IN VENUSIAN CLOUDS AT ALTITUDES 47-63 KM ON 'VEGA-1' AND 'VEGA-2' AUTOMATIC INTERPLANETARY STATIONS

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 2, Feb 86 (manuscript received 27 Sep 85) pp 123-130

[Article by Yu.V. Zhulanov, L.M. Mukhin and D.F. Nenarokov, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] The "Vega" program provides for implementation of an experiment for studying the vertical profile of the concentration and size spectrum of particles in the cloud layer of Venus. A photoelectric method was used for the analysis of aerosols in which particle size is transformed into an electric signal. In the altitude range 47-63 km it was possible to discriminate several stable cloud cover levels: upper cloud level, layer D, above 57 km; intermediate layer C, 50-57 km; lower cloud level, layer B, 47-50 km. The results were consistent with experimental data obtained with the "Venera-9," "Venera-10," "Pioneer-Venus" and "Vega" (with ISAV-A instrument). The boundaries between the B, C and D layers are clearly expressed. The levels of concentrations of particles with a diameter ≥ 0.4 μm in all layers, especially the C layer, measured on the nighttime side, are considerably lower than those measured on the daytime side. The cloud layers are evidently formed during phase transitions of atmospheric components. Their position is determined by the altitude of the isotherms corresponding to these phase transitions. Figures 3; references 10: 4 Russian, 6 Western.

5303/8309
CSO: 1866/92

INTERPLANETARY SCIENCES

UDC 523.4 + 520.8

SPECIALIZED NETWORK FOR DATA RECEPTION AND INTERFEROMETRIC MEASUREMENTS IN BALLOON EXPERIMENT

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 2, Feb 86 (manuscript received 25 Oct 85) pp 131-136

[Article by N.A. Armand, A.F. Bogomolov, V.I. Shevchenko, V.V. Kerzhanovich, Yu.N. Aleksandrov, V.I. Altupin, R.A. Andreyev, A.S. Vyshlov, Yu.N. Gorshenkov, V.N. Dubrovin, A.L. Zaytsev, O.G. Zoteyev, S.P. Ignatov, M.A. Knorin, A.N. Kozlov, B.Z. Kanevskiy, V.I. Kostenko, K.K. Lubny-Gertsyk, L.I. Matveyenko, Ye.P. Molotov, S.V. Pogrebenko, V.I. Rogalskiy, V.A. Rudakov, I.A. Strukov, B.P. Trusov and G.V. Turusin, Space Research Institute, USSR Academy of Sciences, Moscow; Moscow Power Institute, Moscow; Radio Engineering and Electronics Institute, USSR Academy of Sciences, Moscow]

[Abstract] In connection with implementation of the "Vega" project, a special "Vega" receiving-recording system was installed on large antennas at Yevpatoriya, Ussuriysk and Medvezhiye Ozera and on the 25-m antenna at Ulan-Ude and Alushta, forming a specialized network for observing the balloon experiment. A system for routine processing of the signals was established at Yevpatoriya and Ussuriysk. The "Vega" system was for simultaneous registry of signals from the balloon probe and the flyby vehicle in a regime of transmission of one or two carriers spaced by 6.5 MHz. The principal requirements on the system were ensuring frequency stability and a small width of the spectral line of the heterodynes, ensuring a high linearity of the phase-frequency characteristics, multilevel signal quantization and compatibility of the registry system with electronic computers. (A block diagram of the "Vega" system is given and is used in clarifying the structure and functioning of the system.) Frequency measurements from this system were used in Doppler determination of the speed of the balloons, which yielded estimates of wind speed and atmospheric turbulence. Special algorithms were used in extracting meteorological information for most of the contacts. The specialized network registered signals from the balloons during all time periods for which Venus was visible from the territory of the USSR. Figures 2; references 7: 6 Russian, 1 Western.

5303/8309
CSO: 1866/92

INTERPLANETARY SCIENCES

UDC 523.4 + 520.8

INTERFEROMETRIC MEASUREMENTS AND DATA ACQUISITION IN SPECIAL NETWORK OF 'VEGA' BALLOON EXPERIMENT

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 2, Feb 86 (manuscript received 25 Oct 85) pp 137-142

[Article by Yu.N. Aleksandrov, N.A. Armand, A.A. Krymov, R.A. Alekseyev, V.V. Kerzhanovich, S.Yu. Sila-Novitskiy, Ya.D. Khatshelevich, V.I. Yeremov, V.A. Prasolov and F.I. Ryukin, Radio Engineering and Electronics Institute, USSR Academy of Sciences, Moscow; Moscow Aviation Institute, Moscow; Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] The "Vega" specialized balloon network was established in order to reduce instrument and algorithmic losses in the processing of signals from balloons, thereby ensuring a maximum signal-to-noise ratio in the telemetric and very long baseline interferometer systems. The "Vega" system processed and recorded all signals from the balloon and flyby vehicle in digital form on magnetic tape. Two types of algorithms were used in discriminating telemetric information--"open" and "closed." The basis for the processing of interferometer data was an open algorithm similar to that described by V.A. Arkhangelskiy, et al. (KOSMICH. ISSLED, Vol 19, 1981) [a block diagram is given, serving as a basis for a concise description of the algorithm; another block diagram illustrates the algorithm for discrimination of telemetric data.] The main processing center for balloon and vehicle data was at Yevpatoriya. Special procedures were devised for signal correction and improving the signal-to-noise ratio. Magnetic tapes were exchanged with the other participating stations in the Soviet and international observation networks. Figures 3; references: 6 Russian.

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CSO: 1866/92

INTERPLANETARY SCIENCES

UDC 521.9

INTERFEROMETRIC PROCESSING OF SIGNALS FROM 'VEGA' BALLOON PROBE AND FLYBY VEHICLE

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 2, Feb 86 (manuscript received 25 Sep 85) pp 143-148

[Article by L.R. Kogan and Ye.N. Fedoseyev, Space Research Institute, USSR Academy of Sciences, Moscow; State Astronomical Institute imeni P.K. Shternberg, Moscow]

[Abstract] Two balloon probes were dropped into the Venusian atmosphere in June 1985. Their transmitters operated at 18 cm. The method of differential interferometry with a very long baseline was used in order to achieve the necessary accuracy in measuring coordinates ($\sim$20 km) and velocity ($\sim$ 1 m/s). This involved simultaneous reception of signals from the balloons and flyby vehicle by many widely spaced radio telescopes. The basis for determining the trajectory of motion of a balloon relative to the flyby vehicle is the known dependence of phase of the interference lobes on the difference coordinates and their frequency on relative coordinates and relative velocity. The spectral width of the received signal did not exceed 1 Hz. There was dependable signal detection during an integration time of 1 s (Δf = 1 Hz) only when using such large radio telescopes as Yevpatoriya and Ussuriysk. Definite requirements were set on the accuracy of clock synchronization and accuracy of knowledge of the interferometer baseline. The dependence of the longitudinal velocity of the balloons relative to Venus was evaluated. Only after the processing of interferometric information, which is still in progress at the Space Research Institute, will final data be available on both the longitudinal and transverse balloon motions. Figures 3; references 6: 3 Russian, 3 Western.

5303/8309
CSO: 1866/92

INTERPLANETARY SCIENCES

UDC 523.64

PRECISE POSITIONS AND PHOTOMETRY OF HALLEY'S COMET (1982i)

Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 12 No 2, Feb 86 (manuscript received 3 Jul 85) pp 149-155

[Article by S.I. Gerasimenko, N.N. Kiselev and G.P. Chernova, Astrophysics Institute, Tajik Academy of Sciences, Dushanbe]

[Abstract] Halley's comet was investigated by photometric observations at the Sanglok Observatory, Astrophysics Institute, Tajik Academy of Sciences, with the Cassegrainian focus of a 1-m telescope. The comet was photographed on photoplates sensitized with hydrogen. Photometry was with an electrophotometer operating in a photon-counting regime in the BVR system. Observations were made in conformity to the scheme background-comet-background-comet, etc. Each measurement of the background or comet consisted of 10 or 20 10-s exposures with each filter. The comparison stars used were Nos 5 and 6 NGC 1807 with known B and V values; for the band R use was made of the star No 531 in the cluster Pleiades. The photometric parameters M_0 and n were determined. It was found that in the range of heliocentric distances 11-8 a.u., cometary brightness increased slowly ($n \approx 1$), whereas in the region 8-4 a.u. it increased much more rapidly. This behavior of brightness at great r can be attributed to the formation of dust clouds. It was not the cometary nucleus itself which was observed, but a pseudonucleus whose size decreased with an increase in the rate of sublimation of gases. At lesser r the cometary brightness is determined by the ordinary gas-dust atmosphere of Halley's comet. Figures 2; references 25: 8 Russian, 17 Western.

5303/8309
CSO: 1866/92

INTERPLANETARY SCIENCES

UDC 523.45

JOVIAN DECAMETER RADIO EMISSION. II. LOCALIZATION OF REGION OF GENERATION OF S-EMISSION

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 20 No 1, Jan-Mar 86 (manuscript received 5 Feb 85) pp 20-34

[Article by B.P. Ryabov, Institute of Radio Physics and Electronics, Ukrainian Academy of Sciences]

[Abstract] The first part of this research was published in ASTRON. VESTN., Vol 19 No 4, pp 296-318, 1985, devoted to recent observations of Jovian decameter radio emission with the UTR-2 radio telescope. That article gave the characteristics of S-emission registered during each S-storm at frequencies 10-17 or 16-23 MHz. It was found that these S-storms are generated in the magnetic tube of Io near the southern trajectory of the foot of this tube. This is confirmed by the high cross-correlation coefficients for all three parameters of S-storms. One of the possible physical mechanisms explaining the appearance of increased limiting frequencies of S-storms is related to an Alfven wave generated near Jupiter. The observed lag of the main maxima of the principal parameters of S-storms coincides with the travel time of the Alfven wave from Jupiter to Io (40 minutes). The mechanism of appearance of generation of S-bursts can be related to plasma instabilities which form as a result of the high transverse velocity of the movement of the decameter-active zone of the tube of Io through plasma of the near magnetosphere of Jupiter in the southern hemisphere. Figures 4; references 17: 5 Russian, 12 Western.

5303/8309
CSO: 1866/108

INTERPLANETARY SCIENCES

UDC 523.46-862

REASONS FOR CIRCUMPLANETARY RINGS: AUXILIARY MECHANISMS WHICH COULD RESULT IN TIDAL DESTRUCTION OF SOME FORMER SATELLITES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86
(manuscript received 27 Dec 85) pp 298-309

[Article by V.D. Davydov]

[Abstract] A hypothesis on the origin of the rings of Saturn, Uranus and Jupiter from satellites with a relatively thin cryosphere above a molten outer core (possibly consisting of water or aqueous solutions) is proposed. The essence of the proposed mechanism is the conclusion that the boundary of the planetocentric zone of tidal destruction of satellites is not only determined by the density of these satellites, but also their configuration. For two satellites, for example, one of which has a spherical configuration and the other an approximately hydrostatic equilibrium configuration, the radius of the danger zone differs by a factor of 2. It is shown that conditions can arise for the tidal destruction of a satellite without a change in the elements of its planetocentric orbit. This requires a considerable increase in satellite elongation, in which its figure is transformed to a state of hydrostatic equilibrium. The tidal force could bring about such a transformation of the figure after the rigid shell over the molten outer core of the satellite has become sufficiently thin. An increase in the size of the molten core could occur due to heating of the interior by tidal friction, the process of melting of the interior being accompanied by the segregation of heavy minerals in the inner core. A predisposing circumstance for a considerable rate of dissipation of tidal energy is a non-zero eccentricity of the satellite orbit. Intensification of the tidal heating mechanism can favor some effect capable of increasing eccentricity. Such an effect on the orbit of a former satellite evidently occurred in the process of formation of the rings of Saturn. The described mechanism may have played the principal role in origin of the rings of Uranus and Jupiter, but only a secondary role in the origin of the rings of Saturn. References 18: 13 Russian, 5 Western.

5303/8309
CSO: 1866/117

INTERPLANETARY SCIENCES

UDC 523.042:523.42

SPECTROSCOPIC LIMITS OF NO_2, Br_2, Cl_2 AND SO CONTENT IN UPPER LAYER OF VENUSIAN CLOUDS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86 (manuscript received 3 Jul 85) pp 311-314

[Article by V.A. Krasnopolskiy]

[Abstract] The limits of content of NO_2, Br_2, Cl_2 and SO in the upper layer of Venusian clouds has been reassessed on the basis of the most recent Soviet and foreign literature and the discrepancies in published data are resolved by sound but elaborate calculations. The limits are tabulated, together with the key parameters used in the computations. The final content limits are $6\cdot10^{-9}$, $6\cdot10^{-9}$, $8\cdot10^{-8}$ and $2\cdot10^{-10}$ respectively. The limit $f_{Cl_2} \leqslant 8\cdot10^{-8}$ corresponds to $[Cl_2] \leqslant 3\cdot4\cdot10^{11}$ cm^{-3} at 62 km and can be compared with the Krasnopolskiy-Parshev model which gives a maximum $[Cl_2]=6\cdot10^{10}$ cm^{-3} at 65 km and the Yung-Demore model C which gives $[Cl_2] = 1\cdot3\cdot10^{11}$ cm^{-3} at 62 km. The upper limit $f_{NO_2} \leqslant 6\cdot10^{-9}$ corresponds to $[NO_2] \leqslant 2.5\cdot10^{10}$ cm^{-3} at 62 km. Yung and Demore obtained a maximum $[NO_2] = 10^9$ cm^{-3} at 64 km. The limit $[SO] \leqslant 2\cdot10^8$ cm^3 at 70 km can be compared with the findings of Krasnopolskiy and Parshev $[SO] = 5\cdot10^7$ cm^{-3}) and Yung and Demore ($[SO] = 7\cdot10^8$, $1.2\cdot10^9$ cm^{-3} for models A, B, C respectively). The data for f_{SO} are more difficult to reconcile. Figures 1; references 20: 8 Russian, 12 Western.

5303/8309
CSO: 1866/117

UDC 523.42

GEOMORPHOLOGICAL DESCRIPTION OF LAKSHMI PLATEAU (PHOTOMAP OF VENUSIAN SURFACE, SHEET V-4)

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 20 No 2, Apr-Jun 86 (manuscript received 5 Feb 86) pp 83-98

[Article by A.A. Pronin, A.L. Sukhanov, Yu.S. Tyuflin, S.A. Kadnichanskiy, V.A. Kotelnikov, O.N. Rzhiga, G.I. Petrov, A.I. Sidorenko, Yu.N. Aleksandrov, A.P. Krivtsov, V.P. Sinilo, G.A. Burba and N.N. Bobina, Geochemistry and Analytical Chemistry Institute imeni V.I. Vernadskiy, USSR Academy of Sciences; Geology Institute, USSR Academy of Sciences; Central Scientific Research Institute of Geology, Aerial Mapping and Cartography imeni F.N. Krasovskiy; Radio Engineering and Electronics Institute, USSR Academy of Sciences]

[Abstract] The Lakshmi Plateau is situated at the center of sheet V-4. [The photomap is reproduced in the article, accompanied by enlarged fragments of this map and supplemented by a sketch map on which all named features are identified. These served as a basis for a detailed description of the Lakshmi Plateau and an interpretation of the photomaterials. Also given is a newly compiled geomorphological map of the plateau and adjacent areas with 17 types of features identified.] It was concluded that the plateau and the surrounding areas constitute a unified structure formed by a common process. The mechanism of formation of this structure was the ascent of matter from the deep layers to the surface and its horizontal outflow, accompanied by deformations such as folding or the formation of schuppen. Lakshmi was a local center of radial spreading, but the spreading process ended after crumpling of the lithosphere into mountainous structures. It is evident that Venus is a planet with a more complex tectonic history than the primitive members of the Earth group such as the Moon, Mercury and Mars. Figures 8; references 6: 2 Russian, 4 Western.

5303/8309
CSO: 1866/110

INTERPLANETARY SCIENCES

UDC 523.42

GEOMORPHOLOGICAL DESCRIPTION OF ISHTAR TERRA (PHOTOMAP OF VENUSIAN SURFACE, SHEET V-5)

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 20 No 2, Apr-Jun 86 (manuscript received 5 Feb 86) pp 99-111

[Article by A.L. Sukhanov, A.A. Pronin, Yu.S. Tyuflin, M.V. Ostrovskiy, V.A. Kotelnikov, O.N. Rzhiga, G.I. Petrov, A.I. Sidorenko, Yu.N. Aleksandrov, A.I. Zakharov, A.A. Krymov and N.N. Bobina, Geochemistry and Analytical Chemistry Institute imeni V.I. Vernadskiy, USSR Academy of Sciences; Geology Institute, USSR Academy of Sciences; Central Scientific Research Institute of Geodesy, Aerial Mapping and Cartography imeni F.N. Krasovskiy; Radio Engineering and Electronics Institute, USSR Academy of Sciences]

[Abstract] The geomorphology of Ishtar Terra on sheet V-5 of the photomap of the Venusian surface is described. [The photomap is reproduced in the article, accompanied by enlarged fragments of this map and supplemented by a geomorphological map of the corresponding area with 13 types of features identified.] The photomap reveals that most of Ishtar Terra to the east of the Maxwell Montes is covered by areal dislocations of several directions called "parquet." There is a central stable block, smaller peripheral blocks separated from the central block by faults and grabens and zones of mobilized parquet whose matter flowed downslope in the direction of the central block and partially "parquetized" lava strata. The approximate history of successive geological evolution could be outlined on the basis of an interpretation of these photomaterials. It is concluded that the Maxwell Montes were formed as a result of collision between the central block and the Lakshmi Plateau. Figures 4; references: 2 Russian.

5303/8309
CSO: 1866/110

INTERPLANETARY SCIENCES

UDC 523.6

EXPERIMENTAL SIMULATION OF COMETARY PHENOMENA AND SIMILARITY TESTS

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 20 No 2, Apr-Jun 86 (manuscript received 8 Mar 85) pp 112-115

[Article by Ye.A. Kaymakov and Yu.I. Svetov, Physical Technical Institute imeni A.F. Ioffe]

[Abstract] Specialists at the Leningrad Physical Technical Institute began simulation of cometary phenomena as early as 1963, studying the composition and structure of their nuclei. Data were obtained relating to the thermodynamic parameters of ice in a deep vacuum and at low temperatures. On the basis of these and many other studies it was postulated that cometary ice should contain organic compounds such as nitriles, aldehydes, acids and amino acids. Application of such experimental results for explaining observational data has been impeded because the studied models of cometary nuclei have not completely satisfied similarity tests (such similarity criteria as energy processes, chemical composition and spatial relationships, each of which are examined in detail.) Institute specialists postulate that the nuclei of comets have a nonuniform structure. Mineral dust and large bodies are concentrated near the center of the nucleus and could be detected only with the aging and disintegration of comets (the outer regions do not contain such dust). A different type of particles appears with the escape of volatile components. Admixtures of organic matter form porous particles of micron size. Different comets differ quantitatively and qualitatively with respect to these impurities. A method for combined simulation of cometary phenomena has been proposed based on creation of a cloud of monodisperse ice particles measuring 10 μm which in real comets may exist at distances 10^4-10^5 km from their nuclei. The cloud is created by dispersal of fluid mixtures. Application of the method will cast light on the final phase of decay of ice bodies on the periphery of cometary atmospheres and clarify solar-cometary relationships. References 8: 7 Russian, 1 Western.

5303/8309
CSO: 1866 /110

INTERPLANETARY SCIENCES

UDC 523.531

STARS USABLE IN SEARCH FOR PLANETARY SYSTEMS

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 20 No 2, Apr-Jun 86
(manuscript received 17 Jul 84) pp 128-133

[Article by V.A. Zakhozhay and T.V. Ruzmaykina, Earth Physics Institute imeni O.Yu. Shmidt, USSR Academy of Sciences]

[Abstract] Improvements in IR telescopes and interferometers may soon make it possible to detect planetary systems around close stars. Accordingly, a catalogue of stars has been prepared which might be effective in any search for such planetary systems or extraterrestrial civilizations. The selected stars were in a region with a radius of 10 ps from the sun. These stars fell in a number of categories: individual stars most similar to the sun with respect to spectral class and luminosity class; stars suspected of having low-mass satellites; the closest stars having a radius closer than 10 light years; wide binaries, one of whose components may have stable planetary orbits; stars with excess IR radiation. The reasons for selecting stars in each of these categories are discussed. The catalogue now includes 53 such stars. Table 1 lists individual stars similar to the sun; Table 2 gives the stars suspected of having low-mass satellites; Table 3 lists the selected closest stars; Table 4 lists the wide binaries; Table 5 is for the stars with an excess of IR radiation. The planetary systems which might be discovered in such observations would provide important data for studying solar system cosmogony. References 25: 10 Russian, 15 Western.

5303/8309
CSO: 1866/110

UDC 551.510

ESTIMATING MECHANICAL PARAMETERS OF SURFACE MATERIAL ON PHOBOS

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 20 No 2, Apr-Jun 86 (manuscript received 15 Nov 84) pp 155-157

[Article by A.V. Kozenko, Earth Physics Institute imeni O.Yu. Shmidt, USSR Academy of Sciences]

[Abstract] The surface of Phobos is covered with finely pulverized regolith whose mechanical properties can be judged by a study of the morphology of its craters and grooves. The transverse profile of the grooves is smoothed and the walls are gentle with a slope angle less than 10°; a few major grooves have a wall slope up to 30°. Large craters have diameters of several kilometers and are quite deep. Cup-shaped craters in the equatorial zone have sides steeper than 40-50°; the inner sides have a steepness up to 55-60°. The observed slope steepnesses are attributable to different combinations of cohesion and friction parameters. Estimates of these parameters, as well as slope stability, are given. After estimating the mechanical parameters of surface material, its supporting capacity was evaluated. (In making these estimates it was assumed that mean regolith density was about 1 g/cm^3 and gravity was $\sim$ 0.5 cm/s^2. Surface material cohesion determined from craters and grooves was $c_{cr} \approx 0.07$-0.03 N/cm^2 and $c_{gr} \approx 0.005$-0.001 N/cm^2, with the internal friction angle being from 5 to 30°. The difference in these values cannot presently be explained. References 11: 5 Russian, 6 Western.

5303/8309
CSO: 1866/110

DETAILS ON YEAR-LONG CLOSED ENVIRONMENT EXPERIMENT

Moscow SOVETSKAYA ROSSIYA in Russian 8 Aug 86 p 4

[Article by Andrey Bozhko: "Year-Long Expedition: From the Diary of Space Technology Test Subject Andrey Bozhko"]

[Text] "Launching"

5 November. 1715 hours. We enter into the chamber. German Manovtsev, Boris Ulybyshev and I. There are many people on the balcony of the enormous hall where our "spaceship" has been positioned and they are all applauding. We enter and the door closes behind us. The first minutes of our "flight" have passed... All tasks have been allocated among crew members: German, the crew commander and physician, is responsible for "on-board" medical tests and on-going crew monitoring; Boris is responsible for monitoring and preventive maintenance of life support engineering systems; and I am to work in the greenhouse and participate in biological experiments.

What do I know about these guys? German graduated from the 1st Moscow Medical Institute and is now a specialist at a scientific research institute. He participated in expeditions and in chamber experiments, that is, in pressurized chambers with simulation of space factors. As they say, he "roasted" and suffered "oxygen starvation" and was exposed to "noise and vibration." He is an experienced test subject, the oldest among us.

Boris is the youngest. Not a bad technician. According to him, the brightest recollection of his life is his army service.

After supper we prepared our sleeping places -- bunks. I was to sleep in the lower bunk for ten days. German was to sleep in the middle bunk. Ulybyshev was to sleep on the uppermost bunk. Then we would switch. This makes sense because the carbon dioxide concentration is different at different levels.

6 November. Manovtsev is on watch. His tasks include the preparation of food, washing the utensils, scrubbing the floor and reloading the regeneration materials. There is a festive breakfast -- Boris has a birthday. Dough was mixed and bread was baked. No coffee was found and therefore we opened a tin of cocoa.

in the evening German took a pipe in his teeth and sucked on it, trying to dull the need for smoking. Boris looked at it with such longing that German proposed that he do the very same thing. Boris agreed with pleasure.

12 November. Today we have been in the isolation chamber for a week. As before, I am sleeping on the floor. Some discomfort is caused by the individual monitoring belt which must be worn at nighttime. These belts enable the doctors to monitor our condition during sleep on the basis of the registered respiration and pulse rates. Well, we are beginning to get used to sleeping "in harness."

We take turns on watch. We are becoming accustomed to sublimates -- dehydrated food. It is necessary to overcome a number of psychological barriers, including a prejudice against the drinking water in which the food is prepared. After all, it is regenerated from the wastes of the vital functions of the three men within the "starship."

Each of us has been allocated 10 liters of sanitation water for a shower: you hardly succeed in soaping up and it's already over. After 10 days this same water, cleansed of impurities, will be used in washing again... We strive to maintain our athletic abilities; daily, in addition to morning exercises, we do limbering-up exercises.

17 November. Out on the street it is winter, but for us the climate remains constant. One thing is bad -- there is a high humidity.

For the time being time goes rapidly, especially when we sleep during the daytime. Evenings we read, write in our diaries and once in a while look at television.

The air in our compartment is studied not only by doctors and chemists, but also by biologists, who carry out biological tests for microbial cells. With respect to my scientific research work, it will evidently be possible only after the "docking" of the greenhouse.

5 December. It has been exactly a month that we three have been together. Probably the most difficult thing was the month of adaptation to conditions, getting into the swing of it. But its results were rather satisfying. I hope that in the future everything will go well. German is no longer like he was at first. He has become quieter, more tactful, more considerate. Boris is a fairly good comrade; he is friendlier to me than German. And in general the hope has appeared that our life in the future will be simpler. Some experience has already been accumulated.

15 December. Life has shown that two would be better than three. Relationships would go better. When there are three you have a group in which the third person can play on the contradictions of the two, as occurred almost every day under our conditions.

For the time being everyone is healthy. But it is hard to fall asleep. Why? Evidently the recalling and analysis of current events deprives us of normal sleep.

The problem of our interrelationships is beginning to concern me more and more due to frequent disputes with German. We are different people, in many respects with different interests and different education. The increasing contradictions are disquieting. This has to stop... In our behavior we have to be reasonable people.

22 December. Today is Saturday. We sit and wait for dinner. Boris is on duty. He fusses at the stove and there have already been results -- the smell of burning.

We do not play chess with Boris. There have been too many disputes and this has resulted in unpleasantness. Relationships with German have become better after a frank discussion.

24 December. Eve of the New Year. We almost do not realize this. Today we received word that we would have a little holiday tree and that the operator would visit my home and Boris' home (German declined) and on the 31st they would show us the motion pictures taken. Very pleasant news.. why would German turn down such a source of satisfaction?

Tomorrow we will have our hair cut and put on our best clothes, and the day after tomorrow we will sit down to a festive table. It's hard to believe that we will have a little holiday tree, a little living New Year's tree.

We recalled the main results of the outgoing year. Joining the party, we signed three Author's Certificates for inventions and put the work in the laboratory in order. Did a lot of work before the experiment. It can be said without exaggeration that I underwent this difficult transfer to the institute of Biomedical Problems of the USSR Ministry of Health in order to participate in the experiment. And now these stupid doubts: "Why am I here?" "Why do I, like the others, not work on an ordinary schedule?" It seems that there will be no end to the experiment. The faster the time passed, the better. An endless number of times I mentally speed up a year of my life, a year dedicated entirely to science. There is little joy. For the glory of science -- such is the dream of many. And in our "spaceship" all the time is allocated precisely to science. Is that perhaps bad?

Here rest is something different than in ordinary life -- the switching from doing one thing to doing something else. And it is better not to think about what is occurring there, outside the walls...

"DOCKING"

4 January. We are making ready for dinner. Boris is on duty. We have just performed vigorous physical exercises and then rubbed ourselves with a moist towel. Today there is no water for a shower.

Only here, under our specific conditions, have I really appreciated the importance of physical exercises. There is a need for constantly overcoming oneself. This hardens the will. "Really, a man who wins victory over himself is stronger than he who subjugates a city," as was assumed, it appears, in one of the books is a story by E. Hemingway.

5 January. We live with pleasant recollections associated with movies of our families. For us this was the best holiday gift. Boris and I asked that the film be shown twice and we wanted to look at it again and again. After this we express our congratulations to everyone in the control center and begin to prepare dinner. I was on duty and ruined the cabbage. It had to be thawed out slowly but I heated it to the boiling point.

German is frequently very downcast; possibly he is indisposed, does not feel well? I feel sorry for him.

Dreams have also become a source of information and I comprehend them as well as the infrequent television transmissions which help us a great deal in living in isolation, in overcoming our sort of "sensory deprivation."

The experiment, to be sure, is advantageous to us -- primarily with respect to developing some degree of self-criticism, because under our conditions it is impossible to observe just the errors of others, since after all, we make them ourselves. The other day Boris said that our life is assisting him in developing a different relationship with his wife.

But there is no spiritual contact. Now it seems to me that neither Boris nor German could ever become my friends. We are brought together only by the common desire to carry the experiment through to the end.

22 January. Today is a special day for us -- the "docking" of the living compartment and the greenhouse compartment. A new stage in the experiment had begun, a new stage in our life. We had long awaited this event: for me the greenhouse is a laboratory, the beginning of my scientific work. And in general, for everyone this meant an increase in living space, the appearance of a sports "arena" and finally, a "vegetable garden," giving rise to enormous positive emotions, not to mention fresh greens on the table.

By command from the control center I was assigned to open the door into the greenhouse. With great excitement I moved the handle, opened the massive sealed door and entered the greenhouse.

My impressions were unforgettable: blindingly bright lights -- simulators of sunlight, new odors, little surprises -- gifts of friends -- a plush little teddy bear, three wooden cosmonauts and a metal wind-up nightingale which can warble, and most important -- fresh succulent greens, which we had not seen for several months. At our request a cross-bar was installed in the greenhouse compartment and a small passageway remained between the potted plants, making it possible to move other than just in place. It is difficult to describe our joy at the appearance of the plants...

29 January. I enter into the greenhouse compartment. The lights blaze overhead. This is our artificial sun. Here it will be day for 14 days and for the 14 subsequent days it will be night. A change of day and night in the lunar cycle. Such a regime determined the choice of crops: in the greenhouse we are cultivating fast-maturing salad plants which rapidly accumulate biomass: Chinese cabbage, watercress, borage and dill. The sown area is only 7.5 square meters. Due to the greenhouse we have an average of up to 200 grams of fresh greens per day for the three of us.

7 February. Several harvests have already been collected. There was an immediate increase in work, especially for me: I had to perform my regular share of the duties and at the same time take care of the plants. I feel fairly good, far better than before. German's birthday was on 15 February. An effort has to be made to deal with him carefully. He managed somehow to catch a cold and felt indisposed; Boris began to feel a sore throat and this was treated with a eucalyptus leaf preparation. I note that the guys are melancholy more frequently. It is easier for me -- I am not married and I do not suffer due to family ties. German longs a great deal for his home and family. Boris misses his wife and small daughter Svetlanka and frequently looks at their photographs and rereads old letters...

Boris silently showed me blood on the edge of a cup. German with embarrassment had admitted that his gums were bleeding greatly. According to him, the same would happen to Boris and me: the food is too soft and the teeth and gums do not experience the necessary exercise. Now German is asking the medical specialists that they prepare and send us chewing gum for strengthening the gums...

14 March. I just took a shower -- there was very little water. The sense of fastidiousness is already behind -- the thought that this same water has been used by others for washing -- is not alarming. Repeatedly I am ready to say to myself -- the main difficulty in the yearlong experiment is our life together. It seems that it would be better to be alone.

Here much is recalled, much is re-evaluated in general, and confinement in isolation, laying aside the influence on health as a whole, has been personally advantageous for me: more frequently I "dig" into my thoughts, which is not bad.

23 March. German, as always, was the first to get up... He reads out the parameters. The scientific director phoned and communicated that so-called "emergency situations" are proposed for 10-day periods... So that soon we can expect difficult changes in life. Probably this is for the better. I understand, to be sure, that life will be still more complex, but we very much want to break the everyday stereotype.

5 April. A spring day. I have not kept a diary for several days. And it all began on the day when an unfamiliar girl's voice appeared in the support group. Soon in the course of my duties I for the first time talked a little with the girl... and became melancholy. "Is it possible that the entire spring would be a total loss?" I thought. "But here we will not be aware of it at all." Once, by chance approaching the window, I noticed a slit in the blind. At that moment some girl approached and covered the blind. Is this possibly she? Almost the same as I visualized: young, pretty. From that day I lost my former spiritual equilibrium. The thought flashed across my mind: what if I wrote her a note? The diary -- my true silent friend -- was forgotten in those days: I wrote a letter to Violetta. Wrote it and tore up what I had written, wrote another and tore it up...

"Return"

12 April. I awoke suddenly at night, a simple uncomplicated dream just vanished. I recalled: today is 12 April -- Cosmonautics Day. I started thinking about the pleasant, the upcoming holiday meal and that six of the twelve months for which our "space" journey had been planned had already passed. In testing new equipment here, as well as a life support system, our characteristic physical and psychic capabilities, we should exert great assistance to those who sometime will be in circumterrestrial orbital stations, in prolonged spaceflight. This is nice for warming the soul, but thoughts immediately return to what is going on. The remaining six months of the journey look gloomy. Yes, humdrum days, a packed program of medical research, biological and psychological experiments and... complex relationships among three people separated from the entire world by steel walls.

I recalled the clinic where we were before the beginning of the experiment. During the interrogation by medical specialists neither German nor Boris were among those who I mentioned as desirable companions. Alternates were more pleasant in my opinion.

How irritating unnecessary words are! And so everything is understood: for us there is a language of glances; as time has passed the gestures have become entirely clear. Everything is customary to the ultimate, the research program is clear and therefore words have become too strong an irritant. Now I understood why the other day, when German was preparing the breakfast and dropped the meat on the floor, Boris said nothing to him. He only expressively cast a glance at the meat lying on the floor, and then at me, and then went off into the greenhouse compartment. I turned away in silence and also said nothing to German. It went roughly the same way when German accidently dropped on the floor the towel used in drying the utensils and put his feet on one end of it while he wiped the utensils with the other end. A triangle of relationships... It is extremely complex. During the elapsed time each of us three were completely in solitude. This is very difficult, even if one does not take into account the need for having one's hair cut, wiping one's back with a piece of bast, and finally, bath day. It is good that now there is somewhere to go -- in the first four months this would have been impossible: six square meters of living compartment was all there was.

Each of us was faced with a choice: either to endure the offensive, not taking notice and not listening, or to react, and that means, to receive reproach in return and have an immediate aggravation of relationships. I have long endeavored to adhere to the first principle.

The diary is my salvation. I keep it each day. It is my "lightning rod": I can pour out my soul to it. It assists in registering and analyzing events and the details of our current day-to-day existence, which are lost to the memory. I thought some about this and was satisfied that I was able to make entries every day, despite my busyness.

16 April. I have made still another little discovery: if man condemns, criticizes, insults -- the normal reaction to him is the same, but if he is clearly

praised without basis, he begins to criticize himself -- there is a kind of striving for equilibrium. Now I sit in the greenhouse and write. German is "fixing up" Boris for the night. He will sleep without a belt, but from head to foot entwined in electrodes, as that is the way in which nighttime sleep is studied, or better said, "nighttime sleeplessness."

6 June. A functional test on the bicycle-type ergometer. German, as usual, has attached electrodes to my chest with leucoplasters and constricted my neck with a pulse sensor. A cuff has been applied for measuring arterial pressure and the order was given: "Pressure of 600 kg·m"...

I could scarcely breathe, my temples pounded, and I sweated profusely... All this due to the temperature...

12 June. Finally the "emergency regimes" are behind us. Simulation of technical malfunctions, accompanied by an unfavorable change in the parameters of microclimate: a sharp increase in humidity and temperature, a periodic increase in the content of carbon dioxide, with a simultaneous decrease in oxygen, as well as a restriction on drinking water to 1.2 liter per day, a lack of hot food with a total decrease in the ration by 500 calories in comparison with the usual intake. Yes! These 10 days left an unprecedented impression on us. Listlessness, heaviness in the head, nighttime duty, constant sleepiness and an increased body temperature as a result of overheating -- this is all behind now, as if something had suddenly changed, although everything was the same here; the 10-day nightmare was over. My birthday fell in this period and therefore we received the special food for the celebration two days later.

Our stomachs had so shrunk during this time that we could not cope with the ordinary ration. It was involuntarily necessary to prolong the pleasure. Together with congratulations I received flowers with the roots, daisies which I carefully planted in a pot with a substrate, a soil substitute, and put it in the greenhouse compartment. One after another, each of us felt the urge to go and admire these flowers. I recalled that even two flies that had somehow miraculously survived in our chamber on the first day had provided us positive emotions and no one had tried to kill them.

21 June. German admitted that he had not felt well for several days due to a swelling behind the ear, but had hid it from us.

During the communication session the surgeon recommended that German's abscess be operated on. And German proceeded to the operation with our assistance: I froze the place of the incision and Boris wrapped his head after the operation. Now German has cheered up a little, although his head is still in bandages. The bandages do not hinder him from sticking the pipe in his mouth, simulating smoking.

11 July. Boris takes his guitar and goes into the greenhouse, where he sadly plucks the strings. He promised to teach me to play. Unfortunately, this was impossible. We could not cope with our emotions. The division into "teacher" and "student" against the background of our problems in relationships, even on a temporary basis, was impossible.

From time to time we cut each other's hair. To be more exact, Boris cuts my hair and German's hair and I cut Boris' hair. Boris comes out better than I, and German does not even make a try. For this, evidently, in addition to all else, it is necessary to have good relationships. This evening Boris gave German a crew cut. Under our conditions this kind of haircut is the most effective because long hair requires more water for washing. For this same reason German had done away with his beard, of which he was initially very proud.

Why, nevertheless, have our relationships become more complex with each passing day? I more than once recalled the sorrowful examples of the alienation of people who found themselves together under special conditions. An episode from the life of the famed Arctic researcher Fridtjof Nansen and his friend and assistant Johannsen. For almost a year and a half they fought their way from the North Pole to Franz Josef Land, these two men of great self-mastery and courage. In frozen clothes, which could nowhere be dried, they made their way through the masses of ice. Their diet was exclusively dried frozen meat. They used their body heat for heating the flasks of snow for the water they were to drink. But the most difficult thing which they had to endure was each other's company. Close friends, they began to irritate each other so greatly that they almost stopped talking to one another. Upon returning to the mainland, they resumed their friendship. The reason for their relationships during isolation remained unexplained. Is such "incompatibility" under special conditions possibly to be expected?

There is no inbred hostility to one another among us, but at times it is difficult to overcome extreme subjectivism in oneself. This means that one must learn to live under those conditions when the relationships for all three become simply intolerable.

27 September. The monotony of life leads to some blunting of the memory and emotions; I can no longer recall now what I did yesterday.

5 November. Only two hours remain before the finish, prior to "landing," prior to the beginning of a new life. I don't believe it! I am completely calm. I do not believe that all this is real. We are packing up our sleeping bags! Is this possibly a dream?

A. Bozhko, candidate of biological sciences, relates:

Eighteen years have elapsed since those glorious days, so difficult for us. With what have these years been filled? New and interesting work in the reaching of a great dream -- space. It is too bad that the new tasks "split" our crew. But the year-long test welded us together strongly for life. Even immediately after the end of the experiment, when one of the correspondents asked us whether we would prefer the society of one another for participation in such an experiment or on a prolonged flight, we were unanimous: "Yes" -- since we knew one another considerably better than anyone else and had undergone the test of a joint life under extremal conditions.

A. Borisov.

German Manovtsev and Boris Olyanov undergo medical examinations.

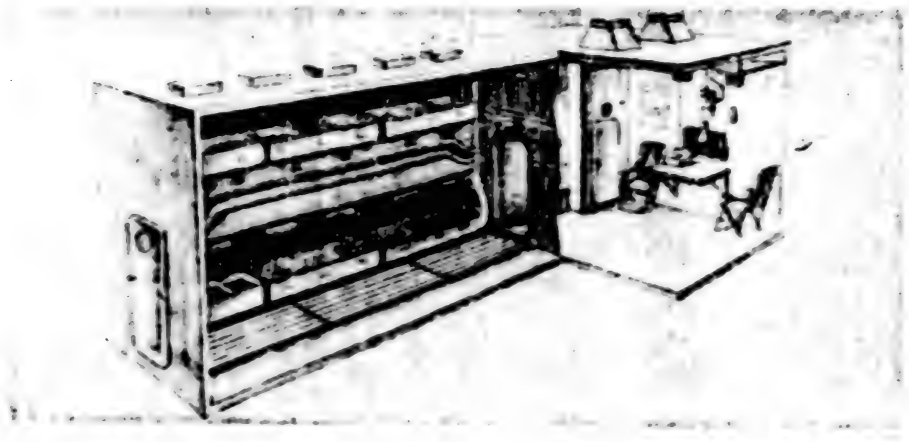

Diagram of "terrestrial starship" (living compartment and greenhouse).

For us the year of stressed work had not passed in vain. German and I soon defended our Candidate's dissertations. Boris has become a leading specialist in the field of monitoring instruments. The experiment also exerted an influence on my personal life. The likable operator in the control group with whom I tried to start a correspondence became my wife. German and Boris were at the wedding. Now Violette and I are raising two sons: Semen and Nikolay.

***

Telegram from Zvezdnyy:

To: G. Manovtsev, B. Ulybyshev, A. Bozhko.

Dear Friends!

Having completed a multimonth flight in space and having executed the set flight research missions, we express to you, the test subjects who carried out the world's first experiment with man's yearlong confinement under conditions close to those in space, our deep appreciation for the difficult work.

-- L. Kizim, USSR flier-cosmonaut, Twice HSU (space flight of 375 days)
-- V. Solovyev, USSR flier-cosmonaut, Twice HSU (space flight of 362 days)

***

Commentary by B. Adamovich, professor, doctor of technical sciences

A problem which to a great extent governs the mastery of space is the development of reliable and efficient life support systems for man during spaceflight. After all, his presence in a spaceship should be as comfortable as possible, and most importantly, safe. Even prior to Gagarin's flight scientists and designers had to solve innumerable problems: what should the cosmonaut breathe -- an ordinary mixture of nitrogen and oxygen (that is, air) or pure oxygen -- and what should they eat -- and what should be the optimum water supply, taking into account that even grams are important aboard a ship.

The experiment answered a very important question: yes, it is really possible to breatne the very same air after purifying it; it is possible to use the same water repeatedly by regenerating it; it is possible to consume sublimated (dehydrated) foods which occupy a small volume and which weigh little. Even if the test subjects had not been faced with other tasks, they accomplished a great deal. And their experiment helped scientists in solving more than one riddle...

Commentary by B. Alyakrinskiy, doctor of medical sciences

In telling about space flights which last more than one year, writers of science fiction have drawn gloomy pictures of the hostility among crew members, hostilities which have led to collapse of an expedition. They did not come to such a conclusion without a basis. Already in the 1950's researchers determined that the lack of ordinary sounds and illumination and inadequacies in communication among people would exert a negative effect on man. It was necessary to find an effective "antidote" against this. Precisely for this reason the yearlong medical-engineering experiment which was carried out under the direction of Professors B. A. Adamovich and Yu. G. Nefedov was directed to a study of the matter of psychological compatibility of the crew, its capacity for working smoothly under extremal conditions of isolation and capability of the test subjects to organize sensible relationships with one another. This experiment provided specialists with a great volume of scientific material and was a definite stage in the development of scientifically sound criteria for screening candidates for prolonged expeditions and systems for their training.

A number of recommendations made in the course of the yearlong experiment have already found practical application aboard orbital stations. Its individual aspects experienced subsequent embodiment in the course of research on life support and the work of crews on long-duration flights.

Commentary by O. Gazenko, academician, director, Biomedical Problems Institute, USSR Ministry of Health

In my opinion, the principal result of the yearlong experiment was that it graphically revealed all the complexities and problems which had to be solved and which still have to be solved in order to ensure a favorable and reliable exposure of man in space. First of all, I have in mind the problem of organizing self-contained ecological life support systems aboard space vehicles. Purposeful and exceedingly complex work in this direction is being carried out in our country and abroad. Definite successes have been attained. Different models of such systems have been tested under terrestrial conditions. For example, in the biological life support system ("man-algae"), developed at our institute on the basis of the photosynthesis of Chlorella, there is assurance of 100% of man's need for oxygen and water without their reserve, a 10% portion of the food (with respect to the calorie requirement of the ration), and also elimination of 96% of the carbon dioxide. In the "Bios" model, developed by scientists of the Siberian Department, USSR Academy of Sciences, with use of a higher plants component, the total regeneration of the atmosphere and water is possible. Attempts are being made to include a small animals component in the "man-plants" system.

Research in this direction is also being carried out on space flights. A system for the regeneration of drinking water from a condensate of atmospheric moisture is functioning on modern orbital stations. During prolonged flights cosmonauts are devoting much attention to experiments with different plants. On one of the Soviet biosatellites, in collaboration with Czechoslovakian specialists, an experiment was carried out with a female quail, a small bird whose meat has a very high calorie content (in addition, it has a high egg-laying capacity), which makes it possible to regard the quail as a promising candidate for use in future life support systems.

However, in order to organize human life-support means aboard space vehicles (for the most part differing little from the conditions for his life on earth) there is still much to be done. In the last analysis, we must have self-contained ecological systems capable of relatively prolonged stable existence on the basis of the closed biological cycling of matter, with "built-in" mechanisms for self-regulation and self-control, as in the case of the earth's biosphere.

The personal impressions of a participant in the yearlong experiment relating to the interrelationships of people who have long been detached from their ordinary living conditions are of interest. Now, when the duration of flights into space is constantly increasing, the number of participants on an expedition is increasing and the business of psychological compatibility in a small group is acquiring ever-greater importance. Experience in prolonged expeditions into space shows that the system which has been developed for psychological screening and training of crews and psychological support during the time of flights is extremely effective. However, here there is also a whole series of problems on which scientists are continuing to work.

This year man has marked the 25th anniversary of his first flight into space. Today Soviet cosmonauts work for months in space, carrying out research and experiments there which are very important and necessary for the national economy. Ahead there are still more complex and interesting tasks. Their solution, the thorough and solid mastery and exploitation of space, requires a constant and careful analysis of everything which has been done, allowance for all our achievements and errors on the thorny path into space. There is a need for returning periodically to the experience of the past. There is a need for using this past experience, taking the best from it for a more and more reliable advance of man along the limitless path into space.

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THE EFFECT OF SPACE FLIGHT FACTORS ON THE MUSCLE SYSTEM

Yerevan BIOLOGICHESKIY ZHURNAL ARMENII in Russian Vol 39, No 3, Mar 86 pp 191-196

[Article by S. S. Oganesyan, Laboratory of Molecular Cardiology, Institute of Cardiology, Armenian SSR Ministry of Health]

Experimental data obtained from studies of various phenotypes of skeletal muscle under conditions of weightlessness are compared with data on the terrestrial modeling of a hypergravitational field and the exclusion of tonic contraction. The mechanism of reverse muscular adaptation to new biomechanical conditions is discussed from the viewpoint of reprogramming the synthesis of individual myofibrillar proteins and their isoforms in relation to the morphological function of muscle fiber. The muscle fiber phenotype is suggested as the limiting factor in adaptive reversible changes.

The elucidation of the molecular-genetic principles underlying the adaptation of the skeletal-motor apparatus, and particularly the muscle system, to prolonged space flight, is one of the most important problems of space biology. In view of the fact that physical training exercises for cosmonauts require considerable expenditures of time in flight, new methods and training devices must be developed that allow one to examine the complex mechanical relationships between the status of the contractile apparatus and the mechanical working conditions of various phenotypes of muscle. In this connection, the biomechanical function of individual muscle fibers as a regulator of the synthesis of individual contractile protein isoforms, is of considerable importance. Another subject of special interest is the study of the reversibility of adaptive shifts and the origin of the information signals that direct the reprogramming of a muscle's phenotype.

The physical-chemical properties of contractile proteins in various phenotypes of skeletal muscle (kinetics of ATPase response, superprecipitation of the actomyosin complex in reactions with ATP, Ca-sensitivity, composition of light and heavy polypeptide components of myosin, and the composition of regulatory protein components) have been studied in animals both in space flights and on the ground. The tonic component deficit in the latter animals was created by suspending the animals by the sacrum so that the rear extremities are off the floor of the chamber and so that they are supported only by their anterior extremities as they move around [2, 9]. The acceleration factor was accomplished by centrifuging the animals on a special centrifuge 322 cm in diameter, for 30 minutes daily for a period of 15 days at 15G. The acceleration vector passed in a head to tail direction.

A comparative analysis was made of the relative amounts of individual myofibrillar protein components and their physical-chemical properties in rapid- and slow-contracting muscles with different structural-functional characteristics, including the isoform content of contractile proteins [11, 12, 19].

The research results on white rat skeletal muscle exposed aboard the Kosmos-1129 space ship demonstrated that significant changes occur in space flight in the amount of individual macromolecular myosin components as well as in the complex of the troponin-tropomyosin regulatory proteins. Thus, additional data was obtained which expanded and confirmed the conclusions drawn from the studies of animal skeletal muscle exposed aboard the Kosmos-605 ship [4].

Table 1. Relative Amount of the Regulator Tropomyosin-Troponin Muscle Protein Following an 18.5-day Flight on the Kosmos-1129 Ship, in relative percentages (M±m). Synchronous group consisted of animals in a mock-up ship on land (average data from 5 - 10 phoregrams of protein preparations)

(1) Мышцы	(2) Группы животных	(3) Тропомиозин	(4) Тропонин-Т	(5) Тропонин-И	(6) Тропонин-С
(7) Плечевая	Контрольная (8)	46.6±1.9	14.0±0.9	21.7±2.4	17.9±0.5
	Полетная (9)	62.3±2.3	8.1±0.4	8.6±2.5	23.0±1.3
	(10) Реадаптированная	44.4±1.5	19.5±0.4	18.3±1.3	17.6±1.7
	(11) Синхронная	38.6±1.8	12.8±0.1	28.0±0.6	20.6±0.6
(12) Медиальная головка трехглавой мышцы	Контрольная (8)	52.2±1.7	12.4±1.3	10.7±3.1	13.3±1.5
	Полетная (9)	65.3±1.4	4.1±0.3	6.0±0.7	24.6±1.5
	Реадаптированная (10)	50.1±0.6	15.6±2.0	28.9±3.4	15.3±2.3
	Синхронная (11)	50.8±1.4	13.9±0.4	14.3±0.4	13.9±2.3
(13) Длинный разгибатель пальцев	Контрольная (8)	51.4±1.1	10.5±0.5	16.1±0.3	18.8±0.8
	Полетная (9)	62.8±2.2	4.9±0.2	13.2±0.3	18.9±1.1
	(10) Реадаптированная	51.9±0.1	5.6±0.3	16.1±0.6	18.8±0.6
	(11) Синхронная	40.8±0.7	10.5±0.1	29.7±0.4	—

Key:

1. Muscles
2. Groups of animals
3. Tropomyosin
4. Troponin-T
5. Troponin-I
6. Troponin-C
7. Brachial
8. Control
9. Flight
10. Readapted
11. Synchronous
12. Medial tip of triceps
13. Long digital extensor

As one can see from the data cited in the table, when the tropomyosin-troponin complex is electrophoretically separated into PAAG there is an increase of troponin-C (Ca-bound protein) in the protein complex of all the examined muscles except the long digital extensor. The latter is characterized by rapid contraction and the lack of an anti-gravitational function. The observed change in the ratio of all three components in the slow muscles takes place as a result of a significant increase in the amount of troponin-C and tropomyosin. The relative amount of almost all the protein components of the complex are fully restored one month after the animals' return to Earth. Consequently, one can say that the adaptive changes within the regulator proteins that occur under the influence of weightlessness, are reversible. The large fluctuations in the amount of troponin-N are possibly due to a supplemental fraction of this inhibitory protein in the band because of its nearly identical molecular weight [1]. At the same time, there was an easily noted trend toward insignificant quantitative changes in the amount of regulatory proteins in the synchronous group that was due to hypodynamics in the absence of the weightlessness factor. These results are in agreement with the data we obtained earlier under other conditions [1, 7].

The results of estimating the quantitative composition of the actomyosin components under G-force stress and the exclusion of the skeletal muscles' tonic contractile element confirm the possibility of adaptive changes in the amount of heavy and light polypeptide myosin chains. This agrees with the data obtained in a study of totally separated myofibrillar protein preparations in animals during space flight [7, 21]. From Diagram 1, one can see that the G-force stress in a hypergravitational field significantly increases the amount of the heavy myosin chains in the region of heavy meromyosin, from 40.3 ± 0.16 to 60.0 ± 0.27 relative % ($P<0.001$). The adaptive reduction in the second light myosin chain apparently induces a change in the ATPase active of actomyosin. We note that the electrophoretic fractions of the proteins were identified by determining their molecular weights through the use of a widely utilized electrophoretic method which employs protein markers. A comparison of the changes that take place in the amount of individual types of light myosin chains in rapid- and slow-contracting muscles allows us to assume that, in the first place, space flight brings about the appearance of genetic myosin isoforms that are characteristic of slow muscles, and in the second place, the appearance of fast muscle isoforms, although transformation takes place more slowly in the latter. Consequently, there takes place in space flight a unification, as it were, of the myofibrillar protein molecular structure. We have found that shifts in the amount of myosin component amounts are also reversible, and that the original distribution of light myosin chains is restored two to three weeks after the animals are removed from the hypergravitational conditions [3]. This has also been experimentally confirmed on board the Kosmos-129 [21]. The times required for the restoration of the original levels of the individual components are not identical, but in principle they coincide with half-restoration times for these proteins, i.e., approximately two weeks.

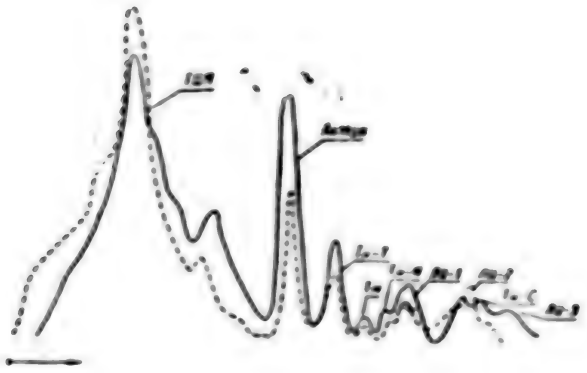


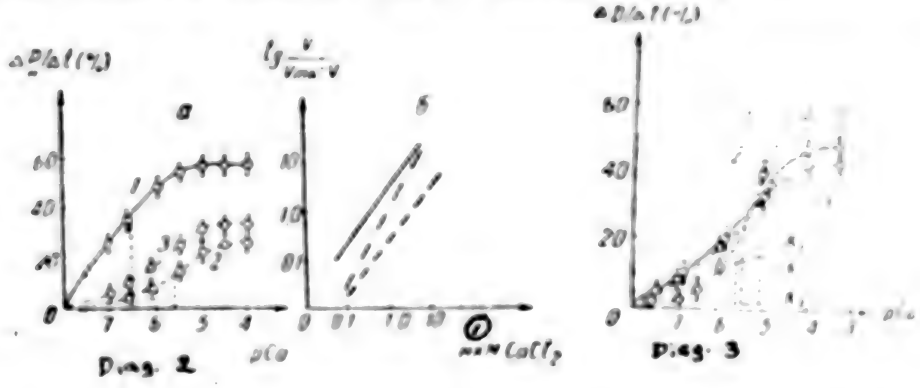
Diagram 1. Densitogram of White Rat Femural Muscle Actomyosin, Electrophoretically Diluted in a 10%-Polyacrylamide Gel in the Presence of 0.1% Dodecyl Sodium Sulfate and 0.1% Beta-Mercaptoethanol. Continuous line indicates the control group of animals. Broken line -- animals subjected to hypergravitation. Symbols: TsM -- heavy polypeptide myosin chains; Tn-T -- tropomyosin-bound component of troponin; Tm -- tropomyosin; Tn-I -- inhibitory component of troponin; LTs1, LtTs2, and LTs3 -- first, second, and third light myosin chains, respectively; Tn-C -- Ca-binding component of troponin.

Key:

1. TsM
2. Actin
3. Tn-T
4. Tn-N
5. LTs1
6. LTs2
7. Tn-C
8. LTs3

The possibility of protein transformation of individual muscle cells, which we noted earlier [18], is confirmed by recent literature data on the existence of genes of various myosin isoforms in an individual muscle fiber [13, 16]. It is important to note that the indicated genes are not evenly distributed in individual types of muscle fibers [14, 15, 17]. Hence we see the relationship between the adaptive transformation of the protein myofibrillar component and the quantitative correlation of the genes that control the synthesis of individual polypeptide chains and that are responsible for the nature of muscular contraction. In particular, the changes in the composition of the polypeptide chains that can react with Ca ions, predetermine the interaction between the active and myosin fibers during the contraction process. There is therefore great interest in determining the kinetic parameters of the ATPase reaction and the superprecipitation of actomyosin (SPP) in relation to Ca ion concentration in the medium.

One can see from Diagram 2 that G-force stress of skeletal muscles under the influence of hypergravitation reduces actomyosin's sensitivity to these ions. This is reflected both in the change of the cooperative degree of the reaction with Ca^{++} and the increase in the Hill factor from 1.3 to 1.7. Since these differences remain even after the removal of troponin and tropomyosin from the actomyosin composition, we assume that the changes in Ca-regulation is due to the adaptive shifts in the myosin molecule, particularly in the active center of ATPase on heavy meromyosin. This supposition is confirmed by the change in the increased maximum activity of ATPase and the Michaelis constant. The restoration of the initial values for a number of kinetic parameters of the fermentation reaction is observed after a two-week readaptive period, although Ca ion activity is only slightly restored. This problem has been studied in greater detail under different forms of skeletal muscle function [3, 8].



Diag. 2

Diag. 3

Diagram 2. Relationship Between the Rate of ATP Hydrolysis by Actomyosin Mg^{++}-ATPase and Ca Ion Concentration (a). Cooperative Degree of the ATPase Reaction in the Hill Coordinates (b). Native Actomyosin of the Control (1), Acceleration-Adapted (2), and Readapted (3) Groups of Animals.

Diagram 3. Relationship Between the Rate of Actomyosin Superprecipitation and Ca Ion Concentration. Symbols are the same as in Diagram 2. K_1, K_2, and K_3 are the Ca ion concentrations which produce a semi-maximum effect.

Key:

1. micromoles $CaCl_2$

One can see from Diagram 3 that a greater number of Ca ions are needed in the animals adapted to G-force stress for a semi-maximum increase in the reaction rate of actomyosin SPP than is required for actomyosin in the control group. Moreover, changes are also observed in the kinetics of the SPP reaction, particularly for the actomyosin of the slow-contracting muscles [9, 10]. These shifts are also reversible within a month's time. A comparison of the data on changes in the SPP reaction rate and ATPase activity indicates that G-force stress leads to an adaptive increase in the work efficiency of the actomyosin contractile "machine."

On the basis of the obtained results we can hypothesize that non-prolonged space flights produce reversible adaptive changes in the contractile apparatus of muscles that are indicative of an integral reprogramming of the muscle cell. One of the principal mechanisms in this situation is the reprogramming of individual genes responsible for the synthesis any particular isoforms of contractile and regulatory proteins. Hence, it is clear that the degree of adaptive reorganization in the protein contractile apparatus depends on the phenotype of skeletal muscles that differ in their composition of genes which control the synthesis of any one particular protein isoform. The considerable mutability of the slow-contracting muscles is also confirmed by the data obtained from experimental measurements of physiological parameters in the contraction of glycerinated muscle fibers and the "Myotest" analysis of human skeletal muscle function [5, 6]. Thus, the significance of the phenotype of skeletal muscles as a factor which limits adaptive responses under extreme conditions must be taken into consideration when prophylactic and restorative training regimens are being developed.

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LIFE SCIENCES

BIOMEDICAL FINDINGS FROM FLIGHT OF COSMONAUTS KIZIM AND SOLOVYEV

Moscow MEDITSINSKAYA GAZETA in Russian 6 Aug 86 p 3

[Article by V. Pishchik, (interviewer)]

[Abstract] The article is an interview with Doctor of Medical Sciences A.I. Grigoryev, first deputy director of the USSR Ministry of Public Health's Institute of Medical-Biological Problems and a director of medical support for space missions. Grigoryev comments on results of medical-biological research conducted during the recent mission of cosmonauts Leonid Kizim and Vladimir Solovyev on the orbiting stations "Salyut-7" and "Mir," and on the cosmonauts' postflight readaptation to terrestrial conditions.

Grigoryev relates that he met Kizim and Solovyev at the Baykonur Cosmodrome within three hours of their landing. Their overall condition at that time could be evaluated as good, although they appeared slightly fatigued, and orthostatic instability was more pronounced in them than it had been before the mission. The cosmonauts' recovery proceeded rapidly during their period of readaptation at the cosmodrome.

Comparing the cosmonauts' activities on the two orbiting stations, Grigoryev notes that medical-biological research on board "Mir" consisted chiefly in recording medical-monitoring parameters. More extensive medical research and a number of experiments were performed on board "Salyut-7," including studies of metabolism and the cardiovascular system. With regard to physical exercises in orbit, which now take from two to two and one-half hours a day, Grigoryev says that medical personnel are still working on the problem of shortening exercise time. They have proposed increasing the amount of exertion, for example. A number of new regimens used in an earlier space experiment called "Sprint" were continued by Kizim and Solovyev during the latest mission, with this end in mind. At the same time Grigoryev foresees no substantial shortening of exercise time--by as much as five-sixths, for example. Physical methods or drugs that would make this possible are unlikely to be found in the immediate future, in his opinion.

Grigoryev responds in conclusion to a question about effects of repeated space missions on cosmonauts. Practice is said to indicate that experience which cosmonauts acquire in their initial missions not only improves their performance but gives them certain psychological advantages on subsequent ones. Their reactions to weightlessness are less pronounced, for example. This may be partly due to the fact that their physiological systems, primarily regulatory ones, retain a 'memory' of their previous encounter with space. For the purpose of clarifying this question, careful studies are being made of cosmonauts' reactions to effects of space-flight factors and of interactions between the human organism and space, Grigoryev relates.

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DISCOVERY OF ZERO-GRAVITY EFFECT ON MITOSIS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 20 Jun 86 p 2

[Article by N. Ilinskaya]

[Excerpt] Yesterday, a new scientific achievement in the field of space biology was recorded as No 318 in the State Register by the USSR State Committee on Inventions and Discoveries. The authors of this discovery are Moscow scientists: Doctor of Medical Sciences V. Antipov, and candidates of biological sciences N. Delone and G. Parfenov.

Before the first experiments on artificial Earth satellites, the only information that was available regarding effects of zero gravity on living organisms was from experiments that lasted only a few dozen seconds. These data were obtained with the aid of special sondes and in special experiments involving stunt-flying of airplanes.

The essence of the Soviet scientists' discovery is that the effects of zero gravity on the fundamental biological process of cell division have been demonstrated for the first time. Mitosis is the universal process of cell division in higher organisms. Different versions of experiments with tradescantia plants were conducted on the spaceships "Vostok-3" through "Vostok-6" and the "Voskhod," and on "Cosmos-110" and other spacecraft. These experiments demonstrated that changes in mitosis occurred in as many as 3 percent of the plants' cells. The characteristics of these changes were also studied in detail.

"In no experiment conducted in terrestrial conditions were such changes in cells observed, even from the effect of radiation, vibrations and temperature shocks," related N. Delone, a docent at Moscow State Medical Institute No 2.

The data which the Soviet scientists obtained have provided impetus for intensive advancement of research of zero gravity's effects on cells of various organisms.

The discovery's scientific significance lies in the fact that it characterizes zero gravity as a biologically active factor on the cellular level. Appraising its practical significance, academician N. Dubinin said: "The discovery undoubtedly will play a role in further successful exploration of space by humans. The regularities which have been discovered will allow important recommendations to be made in regard to ensuring the safety of prolonged missions in space."

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FURTHER COMMENT ON IMPAIRMENT OF CELL DIVISION BY ZERO-GRAVITY

Moscow MEDITSINSKAYA GAZETA in Russian 20 Jun 86 p 4

[Article by R. Akhmetov, correspondent]

[Excerpt] On 19 June a scientific discovery made by Moscow scientists who are associates of the Medical Institute No 2 and of the Institute of Medical-Biological Problems of the USSR Public Health Ministry was registered at the USSR State Committee on Inventions and Discoveries. Docent N.L. Delone and doctors of biological sciences V.V. Antipov and G.P. Parfenov discovered a fundamentally new phenomenon: impairment of the mechanism of cell division in conditions of zero gravity.

"We demonstrated for the first time that zero gravity affects such a basic biological process as cell division," related Professor V.V. Antipov. It was found that division is impaired in approximately 3 percent of the cells of plants from the effect of zero gravity.

"American researchers who flew in space confirmed the results of our scientific discovery.

"The same phenomenon was subsequently recorded by other Soviet scientists in muscle cells of turtles and rats and in cells of flies and beetles. Interestingly, cells that divided normally produced new generations of cells with the same percentage of impairments.

"I wish to emphasize that the loss of such a small number of cells does not affect the viability of an organism as a whole or any aspects of its vital activity. Experiments on board spacecraft have demonstrated that all stages of plant development--germination of seeds, formation of primary organs, blooming, and maturation of seeds--can take place normally in zero gravity.

"Work on development of closed ecological systems presumably will become more intensive in the future, considering the prospects for further study and exploration of space with the aid of orbiting stations. A priority of this work will be development of space hothouses which will assume the function of partially regenerating the atmosphere inside orbiting stations, and the plants grown in them will be used in crews' food rations. Hothouse cultivation in space is precisely where results of the scientific discovery will be particularly applicable. We are studying possible mechanisms of hereditary transmission of cell impairments in conditions of zero gravity, as well as predisposition of cells to this phenomenon."

INTERNATIONAL SYMPOSIUM ON RESULTS FROM 'COSMOS-1667' BIOSATELLITE

Moscow MEDITSINSKAYA GAZETA in Russian 11 Jul 86 p 3

[Article by V. Pishchik]

[Excerpt] At an international symposium which was held in Moscow, specialists in the field of space biology and medicine from the USSR, Bulgaria, Hungary, the German Democratic Republic, Poland, Romania, the United States, France and Czechoslovakia, who had participated in the experiment on the biosatellite "Cosmos-1668," discussed the results of this flight and outlined ways of further cooperation.

On the eve of the opening of the symposium, I visited one of the laboratories of the Institute of Medical-Biological Problems of the USSR Ministry of Public Health, where last summer the monkeys Vernyy and Gordyy were readied for the space flight and where they returned after its successful completion. They are feeling well. They spent seven days in space along with the other 'passengers' of the biosatellite--rats, fish, amphibians and plants. For a year, the data obtained during the flight were meticulously processed and analyzed in many laboratories.

As is known, seven biosatellites have been launched in the Soviet Union since 1973. Most of them were launched as part of a broad international cooperative endeavor with the participation of member nations of the Council for Mutual Economic Aid, and of the United States and France.

In the opinion of the scientists, many of the results obtained can be regarded as being of fundamental importance. These are data indicating that weightlessness does not have a direct damaging effect on intracellular processes, including the mechanisms of transmission of hereditary information. This is being taken into account in the medical substantiation of the possibility of prolonged manned flights. Studies of the skeletomuscular system of animals have experimentally confirmed the effectiveness of using both dynamic and static physical loads in manned flights. Of great importance are the results of experiments in which the growth and development of organisms, aging processes, and the long-term effects of space flights were studied. This also represents a substantial contribution to the solution of many problems pertaining to the radiation safety of space flight crews.

Analysis of the redistribution of the blood in the organism of monkeys, the function of their vestibular system, and the dynamics of the indexes of the functional condition of the muscles and of metabolic changes, together with the data obtained during manned flights, makes it possible not only to control more and more completely the changes occurring during the initial period of space flight, but also to control the process of adaptation to zero gravity.

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MODIFICATION OF CYTOGENETIC AND PHYSIOLOGICAL EFFECTS OF SPACEFLIGHT FACTORS BY BIOLOGICALLY ACTIVE COMPOUNDS

Moscow ZHURNAL OBSHCHEY BIOLOGII in Russian Vol 47 No 2, Mar-Apr 86
(manuscript received 14 May 84) pp 246-251

[Article by A.A. Aliyev, E.R. Mekhti-Zade, A.L. Mashinskiy and U.K. Alekperov, Botany Institute imeni V.L. Komarov, Azerbaijan Academy of Sciences, Baku; All-Union Scientific Research Institute of Biotechnology, Moscow]

[Abstract] Due to the numerous factors operative on the plant organism under spaceflight conditions they should be neutralized against negative effects by use of biologically active compounds whose protective or regulatory properties have a universal character. A study was therefore made of the use of vitamin E and phytohormones for modifying spaceflight-induced effects on mutation and growth processes in plants after exposure of plant seeds to spaceflight conditions. The research was with seeds of Welsh onion. The seed controls were stored in the laboratory at room temperature and humidity for 82 and 522 days. These were the same periods during which experimental seeds were aboard the "Salyut-7." The influence of seed storage and seed spaceflight on the organism was judged from germination parameters, mitotic index and frequency of chromosome aberrations in cells of the apical meristem of roots, the rate of their growth, and stem height on the 10th day after seen germination. The seeds were germinated in solutions of α-tocopherol, auxin and kinetin. It was found, for example, that solutions of α-tocopherol and kinetin favor a decrease in the frequency of chromosome structural rearrangements. Auxin completely eliminates inhibition of cell proliferation in the root meristem caused by spaceflight factors and restores and even stimulates the growth of the above-ground part of plants, although this phytohormone is only an initial stimulus to restoration of hormonal status and performs a signal function, triggering the mechanism of autoregulation of cell division and plant growth. The modifying effect of vitamin E is in the form of compensation for the negative effect of spaceflight factors. The observed antimutagenic effect of vitamin E, auxin and kinetin is evidence of the possibility of their use for protection of the genetic system against mutational damage and ensuring its functioning under different extremal conditions. Figures 2; references 27: 21 Russian, 6 Western.

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ABIOLOGICAL SYNTHESIS OF URIDINE NUCLEOTIDES DURING FLIGHT OF 'SALYUT-7' ORBITAL STATION

Leningrad ZHURNAL EVOLYUTSIONNOY BIOKHIMII I FIZIOLOGII in Russian Vol 22 No 1, Jan-Feb 86 (manuscript received 20 Nov 84) pp 17-23

[Article by Ye.A. Kuzicheva and N.V. Tsupkina, Cytology Institute, USSR Academy of Sciences, Leningrad]

[Abstract] The abiogenetic synthesis of nucleotides was used in obtaining experimental evidence of possible stages in the prebiological evolution of biologically important compounds under extraterrestrial conditions. A modification of the Lohrmann-Orgel method (SCIENCE, Vol 171, Vol 171, [as printed], pp 490-494, 1971) was used in the synthesis of nucleotides. Chromatographically pure preparations of uridine, uridine-2',3' -cyclophosphate, uridine-5'-monophosphate, sodium hydrophosphate, urea and ammonium chloride were used in such synthesis employing UV radiation at 254 nm and thermal energy (50±2°C). The methods employed included ion-exchange, thin-layer and paper chromatography, gel filtration, spectrophotometric measurements, acid and enzymic hydrolysis. The laboratory experiments demonstrated that thermal energy leads to the formation of uridine monophosphates--cUMP, 5'UMP and the mixture 2'(3')-UMP; a monophosphate was synthesized close in properties to cUMP. In two series of flight experiments on the "Salyut-7" it was possible to obtain 5'-monophosphates and a mixture of 2'(3')-monophosphates. It is postulated that each type of energy characteristic of the primitive Earth and still operative in space was fundamental in processes of prebiological evolution of biologically important compounds. Such prebiological reactions could once transpire in the earth's lithosphere, in the lithosphere of planets of the earth type or on particles of interstellar dust. Research of this type is important for understanding the origin of life on the Earth. Figures 5; references 15: 9 Russian, 6 Western.

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LIFE SCIENCES

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DOSE CHARACTERISTICS OF COSMIC RAYS ON FLIGHT PATHS OF HIGH-ALTITUDE AIRCRAFT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86
(manuscript received 27 Jun 84) pp 314-319

[Article by Yu.I. Barannikov, O.A. Barsukov, and P.F. Gavrilov]

[Abstract] As the use of high-altitude aviation increases there will be a continuing increase in the number of people exposed for a prolonged time at altitudes of more than 10 km and subjected to an additional dose load which must be taken into account in estimating total human irradiation dose. Accordingly, an estimate was made of the levels of ionizing radiation in the atmosphere, an estimate of the intensity levels of the equivalent dose arising from different components of cosmic rays at the flight altitudes of modern passenger aircraft, a determination of their dependence on altitude above sea level and latitude. In the computations use was made of data on the fluxes and angular distributions of the components of galactic cosmic rays published in the literature. The estimates are not meant to be strictly rigorous because the equivalent dose is distributed nonuniformly over the body and is dependent on its position relative to surrounding objects. A table gives the computed distribution of the intensity of the equivalent dose by species of particles and energies at an altitude of 16 km with a geomagnetic rigidity cutoff of 3.5 GV (separately for protons, neutrons, electrons and gamma quanta). The altitude curves of the dependence of the total intensity of the equivalent dose of galactic cosmic rays is characterized by the presence of a maximum at altitudes from 20 to 17 km. The position of this maximum is dependent on the geomagnetic rigidity cutoff and on the solar activity level. With an increase in the cutoff rigidity or an increase in solar activity the maximum of the altitudinal dependence is displaced in the direction of lesser altitudes. The absolute values of the equivalent doses of galactic cosmic ray irradiation vary widely in dependence on the solar activity level. Figures 6; references 8: 5 Russian, 3 Western.

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NUMBER OF IMPULSES IN COPLANAR MINIMUM-FUEL FLIGHT BETWEEN CLOSE KEPLERIAN ORBITS

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian No 22, Oct 85 (manuscript received 10 Oct 84) pp 67-73

[Article by S. V. Agaponov, S. N. Kirpichnikov and I. N. Slobodzyan, Leningrad State University]

[Text] This article is devoted to a refinement of the results given in [1] on the number of impulses in minimum-fuel coplanar flight between stipulated Keplerian elliptical orbits. It is assumed that such an interorbital flight maneuver is impulsive and that its characteristic velocity is minimized.

In contrast to the problem of flight between orbits, in which it is necessary to transfer from an initial to a final orbit, in the problem of flight between stipulated orbits, with a start from an initial orbit, it is only necessary to intersect the final orbit. In the latter case we have the optimization problem with a moving right end and the need arises to take into account the transversality conditions at this end. Then, in the considered problem of interorbital flight it is natural to assume that limiting orbits are not intersected.

At the same time, consideration will be given to the coplanar problem of determining an impulsive minimum-fuel optimum maneuver for eliminating intersection of stipulated near-Keplerian limiting orbits; this is closely related to the problem formulated above. Here it is assumed that the initially stipulated limiting orbits are intersected and it is necessary to execute an interorbital maneuver, as a result of which the last Keplerian segment of the flight orbit will only touch the final orbit. The direction of escape (into the outer or inner part of the region bounded by the final orbit) is without importance.

In this article we will determine the maximum number of necessary impulses (fractional impulses are not allowed) in optimum maneuvers in each of the two extremal problems considered above, depending on the parameter zero approximation of e for the eccentricity of limiting orbits.

We will use the method (see [2, 3, 1]) developed for studying problems of such a type. With this method both the problems examined here are essentially reduced to study of the following controllable system for speed:

$$dy/du = f. \tag{1}$$

where $y = (y_1, y_2, y_3)$ is the vector of phase variables

$$y_1 = \frac{p}{p_0} - 1, \quad y_2 = \sqrt{\frac{p_0}{p}}\, e, \quad y_3 = \frac{1}{\sqrt{p}}\, \omega, \tag{2}$$

where p, e, ω are the focal parameter, eccentricity, angular distance of the osculating flight orbit, and p_0, e_0, ω_0 are the values of the enumerated variables corresponding to the initial orbit.

For the vector $$f = (f_1, f_2, f_3) = f(v, \Phi, e)$$

of the right-hand sides of system (1) we have

$$\left.\begin{aligned} f_1 &= \sin v \cos \Phi + \cos v \sin \Phi (2 + e \cos v)(1 + e \cos v)^{-1}, \\ f_2 &= -\cos v \cos \Phi + \sin v \sin \Phi (2 + e \cos v)(1 + e \cos v)^{-1}, \\ f_3 &= -\sin \Phi (1 + e \cos v)^{-1}. \end{aligned}\right\} \tag{3}$$

The true anomaly v and the Φ angle of thrust inclination to the radial direction are controlling parameters with a control region determined by the relations

$$v \in (-\pi, \pi], \quad \Phi \in (-\pi, \pi]$$

The independent variable u of system (1) is equal to the ratio of the characteristic maneuver velocity, taken in ordinary dimensionality, to the gravitational parameter. In accordance with the adopted accuracy, on the right-hand sides of (3) of system (1) the Keplerian orbital elements are replaced by their constant zero-approximation values. (The possibility of such a replacement is a result of the postulated closeness of limiting orbits.) Finally, we assign the phase space of system (1) the structure of Euclidean space, regarding the Euclidean vector space $R^3 = \{y = (y_1, y_2, y_3)\}$ as its coordinate space.

For use of the Pontryagin maximum principle we introduce the Pontryagin function $H = (\lambda, f)$, where $\lambda = (\lambda_1, \lambda_2, \lambda_3)$ is the vector of conjugate variables, in this case a constant non-zero vector. Computing the maximum of the H function from the controlling parameter Φ, we find

$$M(\lambda, e, v) = |\max_{\Phi} H|^2 = (\lambda_1 \sin v - \lambda_2 \cos v)^2 + \frac{[\lambda_1 \cos v + \lambda_2 \sin v)(2 + e \cos v) - \lambda_3]^2}{(1 + e \cos v)^2}. \tag{4}$$

Now our task is to find for each stipulated eccentricity value $e \in [0, 1)$ the maximum number r(e) of different values of the variable v at which M function attains an absolute maximum for this variable with all possible admissible values of the λ vector of conjugate variables. The same as in [2], it is easy to demonstrate that $r(e) \leq 3$. In the problems investigated here the λ vector is not arbitrary, but satisfies the transversality conditions. These conditions were defined in detail in [1]. We will briefly mention their derivation, giving heed to the facts which we will need later.

Supplying the parameters in (2) whose values correspond to the final orbit with the subscript "f" for "final," we introduce the function

$$\Psi = \Delta y_2^2 + (e\Delta y_2 + \Delta y_1)^2 - 4\Lambda y_3^2, \tag{5}$$

where

$$\Delta y_i = y_i - y_{i0}, \quad i = 1, 2, 3. \tag{6}$$

We note that in the approximation which we adopted the condition $\Psi = 0$ is the condition of tangency of the last Keplerian segment of the flight orbit and the final orbit, and the condition $\Psi \geq 0$ is the condition of their intersection.

In the phase space $R^3 = \{y\}$ of system (1) we introduce the sets

$$\left.\begin{aligned} &Q = \{y \mid \Psi \leq 0\}, \quad D = \{y \mid \Psi \geq 0\}, \\ &K = \partial Q = \partial D = \{y \mid \Psi = 0\}, \\ &Q_+ = \{y \mid \Psi < 0, \ \Delta y_3 > 0\}, \quad Q_- = \{y \mid \Psi < 0, \ \Delta y_3 < 0\}. \end{aligned}\right\} \tag{7}$$

The sets Q, D, K are cones with a peak at point y_f, with (2) corresponding to a final orbit. The inner part of the cone Q is an uncoupled joining of two convex sets Q_+, Q_-. The points of the sets Int $Q = Q_+ \cup Q_-$, D and K correspond to Keplerian orbits not intersecting with the final orbit, intersecting with it and tangent to it respectively. The orbits corresponding to the set D_-, situated outside, and the set Q_+, situated within the region bounded by the final orbit in the plane of the limiting orbits.

The point y_0, whose parameters (2) are for the initial orbit, in the problem of organizing a minimum fuel flight, is in the set Int $Q = Q_+ \cup Q_-$, and in the problem of minimum fuel elimination of orbital intersection, in Int D. In both problems it is required that as a result of an interorbital maneuver the phase trajectory passes to the limiting set -- the cone K determined by the condition $\Psi = 0$. Therefore, the transversality conditions will be

$$\lambda = \nu \operatorname{grad} \Psi, \quad \nu = \text{const} \neq 0. \tag{8}$$

It is easy to see that the class of maneuvers corresponding to the peak y_f of the cone K cannot increase the maximum number of impulses sought here and therefore we excluded this peak from consideration.

The problems involved in determining the sought-for maximum number of impulses fall in the field of problems in the synthesis of optimum control, in which the entire set of admissible values of the parameters determining the limiting orbits must be included in the computations. Accordingly, using the boundary condition $\Psi = 0$ and the transversality conditions (8) for excluding the parameters of the final orbit, we find that the set of admissible values of the vector λ of the conjugate variables in the investigated problems is a cone (without a peak):

$$4(\lambda_1^2 + \lambda_2^2) = (\lambda_2 - \lambda_1 e)^2. \tag{9}$$

Finally, we take into account that the set of velocities (indicatrix of admissible velocities) of system (1) and its convex envelope, which we will consider directly in the phase space R^3, are centrally symmetric relative to the point y_0. Accordingly, it is sufficient to limit ourselves to study of a set

of admissible values of the λ vector, which is parameterized by a new auxiliary variable $\varphi \in (-\pi, \pi]$ in the form

$$\lambda_1 = \cos\varphi,\ \lambda_2 = \sin\varphi,\ \lambda_3 = 2 + e\cos\varphi \tag{10}$$

We will show that three-impulse maneuvers are not optimal in both the studied problems. Repeating the reasoning and computations in #3 of [3] and converting to the variables used here (2) and the corresponding conjugate variables λ_1, λ_2, λ_3, we find that for the realization of optimum three-impulse maneuvers it is necessary that the vector of conjugate variables with an accuracy to an insignificant non-zero constant factor, be equal to

$$\lambda_1 = e(2e-1),\ \lambda_2 = 2\sqrt{1-e^2},\ \lambda_3 = (2e-1)(4e-3). \tag{11}$$

From equations (9), (11) we find the equation for eccentricity

$$(1-e)(1-2e)(2e^4-15e^3+45e^2-81e+81) = 0, \tag{12}$$

which does not have real roots in the region $e \in (0.925\ldots, 1)$ of existence of three different points of the absolute maximum of the function (4) found in [3].

Thus, with all eccentricity values $e \in [0,1)$ the number $r(e) \leq 2$, that is, the maximum number of pulses in both considered problems is not greater than two. Therefore, we will proceed to an investigation of the problem of the existence of optimum two-impulse maneuvers.

The function (4), by means of the equalities (10), is represented in the form

$$M(\varphi, e, v) = \frac{[\cos(v-\varphi)(2+e\cos v) - (2+e\cos\varphi)]^2}{(1+e\cos v)^2} + \sin^2(v-\varphi) \tag{13}$$

We will point out some properties of the function (13). First of all, factoring out $\sin^2 v\ \varphi/2$ on the right-hand side of formula (13), it is easy to find that $M(\varphi, e, v) \geq 0$; the M function attains an absolute undegenerate minimum, equal to zero, with a value of the variable $v = \varphi$.

Next, the M function is invariant relative to replacement of the variables $v \to -v$, $\varphi \to -\varphi$. Accordingly, its level lines on the Euclidean plane $R^2 = \{(v, \varphi)\}$ are centrally symmetric relative to the origin of coordinates. The latter property making it possible, without limiting universality, to narrow the interval of change of the φ variable to the segment:

$$\varphi \in [0, \pi] \tag{14}$$

Finally, it is easy to establish that the $M(\varphi, e, v) = 1$ function, if

$$|v - \pi| \geq \arccos\frac{2+e}{3}. \tag{15}$$

The latter property makes it possible, in numerical investigations, to somewhat narrow the range of change of parameters in a search for the absolute maximum of the function (13).

The nature of behavior of the function was studied numerically in [1]. The author found the critical eccentricity value

$$e_* = 0.774806\ldots \tag{16}$$

such that for $0 \leq e \leq e_*$ the function (13) with an arbitrarily fixed value of the φ parameter has only one critical point of the maximum. On the other hand, for any value $e > e_*$ there is some value of the parameter $\varphi = \varphi(e)$, unique in the interval (14), with which the M function attains an absolute maximum at two different points $v_1 = v_1(e)$, $v_2 = v_2(e)$, so that $r(e) = 1$ for $e \leq e_*$ and $r(e) = 2$ for $e > e_*$. The numerical computations in that study also indicated that the critical value e_* is the bifurcation point of the degenerate absolute maximum of the M function such that in it

$$M_v' = 0,\quad M_{vv}'' = 0,\quad M_{vvv}''' = 0, \tag{17}$$

and the refined value (16) itself was obtained by numerical solution of these equations (17).

Using a representation of the Pontryagin function H and the special variables introduced in [4], system (17) can be reduced to one fourth-degree polynomial equation. For this purpose we convert from the variables v, φ to the Φ variable and the new variable k using the formulas

$$\left.\begin{aligned} k &= \frac{\cos(v-\varphi) - 1 + e\cos\varphi}{\cos(v-\varphi) + e\cos v - 2 + e\cos\varphi}, \\ \operatorname{ctg}\Phi &= (1-k)\operatorname{tg}\frac{v-\varphi}{2}. \end{aligned}\right\} \tag{18}$$

Now, after a number of unwieldy transforms, from equation (17) we obtain

$$k^4 - 5k^3 + 16k^2 - 28k + 8 = 0, \tag{19}$$

$$e^2 = \frac{(k-1)(k^4 - 4k^3 + 21k^2 - 20k + 8)}{k^2(4k-5)}, \tag{20}$$

$$\operatorname{ctg}^2\Phi = \frac{k-1}{k-2},\quad e\cos v = \frac{k^4 - 4k^3 + 14k^2 - 16k + 4}{k^2(k-4)k}. \tag{21}$$

Equation (19) has two real roots: $k_1 = 0.544903\ldots$, $k_2 = k_* = 0.942437\ldots$ Among these the first root k_1 corresponds to an eccentricity value greater than unity, whereas the second root $k_2 = k_*$ corresponds to the e_* value; the corresponding values of the variables v, φ, Φ are

$$\left.\begin{aligned} v_* &= -2.03\ 693\ldots,\quad \varphi_* = 2.53\ 396\ldots, \\ \Phi_* &= -1.18\ 677\ldots \end{aligned}\right\} \tag{22}$$

Then it is easy to show that with the values of the variables (16), (22) the M function has an absolute maximum for the variable v, which is attained at a single point and has second-order degeneracy, since the derivative $M_v^{4} < 0$ at the considered point.

In order for subsequent reasonings and proofs to be more graphic, it is convenient for us to transform to geometrical language. For example, the λ vector of the conjugate variables will play the role in phase space as the vector of the normal to the reference hyperplane of the convex envelope of the set of velocities in system (1), directed into the half-space not containing this

convex envelope. The set of velocities in system (1) itself will be examined with an accuracy to similarity, as the similarity coefficient using the characteristic velocity u in such a way that with an increase in u the set of velocities increases, whereas with a decrease in u it decreases, being transformed to the point y_0 when u = 0. The assumption of closeness of the limiting orbits makes it possible, as before, to identify the attainability set of system (1) from the point y_0, corresponding to the characteristic velocity u, with the corresponding set of velocities. Now at the boundary of the convex envelope of the set of velocities in system (1) we discriminate the set V of points for each of which the hyperplane which is a reference for the set of velocities, containing this point, has the vector λ of the normal pertaining to the cone (9).

We established above that with $e < e_*$ all the points of the part V of the convex envelope of the set of velocities fall in this same set of velocities, and in addition, at points of the set V the convex envelope is locally rigorously convex, that is, each reference hyperplane at some point of the set V is intersected by the convex envelope of the particular set of velocities at this one point. It therefore follows that here, with a gradual increase in the characteristic velocity u from zero, the initial contact of the set of velocities with the cone K will always occur at isolated points of the set V, that is, the points lying in the set of velocities itself. This means that when $e < e_*$ in both investigated problems only one-impulse maneuvers can be optimum.

Now assume that $e > e_*$. Here in the set V there will be two and only two one-dimensional open simplexes, centrally symmetric relative to the point y_0, lying rigorously over the set of velocities of system (1). The corresponding simplex, corresponding to conditions (14), is designated S. Thus, for $e > e_*$ there was satisfaction of the necessary optimality conditions for any such two-impulse maneuvers corresponding to the mentioned open simplexes. In studying the optimality of these maneuvers we will make a more detailed investigation of the possible structural content of this particular set V with the cone K at the points of the simplex S. Here an important role will be played by the angle ϑ between the direction of the simplex S and the generatrix of the cone K passing through the point of tangency of the simplex S and the cone K.

A program was prepared for numerical computation of the ϑ angle on an electronic computer with eccentricity values $e \in (e_*, 1)$. In this program, as in the numerical computations in [1], for each eccentricity value e, the first step was to compute the values of the true anomaly $v_1(e)$, $v_2(e)$, giving the absolute maximum of the M function and the corresponding values of the angles

$$\Psi(e), \quad \Psi_1(e) = \Psi|_{v=v_1(e)}, \quad \Psi_2(e) = \Psi|_{v=v_2(e)}.$$

Then the angle $\vartheta = \vartheta(e)$ was found using the formula

$$\vartheta = \arccos \frac{(a, b)}{|a||b|}, \tag{23}$$

where

$$\psi = \{ \quad \} \tag{24}$$

$$\lambda = \{ \quad \}, \tag{25}$$

are vectors, the first of which is collinear to the simplex S, whereas the second is directed along the orthogonal vector λ of the generatrix of the cone K.

The results of the computations are represented graphically in the figure.

Comment. Using the representation of the Pontryagin function developed in [4], it is possible to derive an equation implicitly determining the dependence $\psi = \psi(e)$ in a form (for this it is necessary to equate the discriminant of the fourth-degree polynomial in formula (8) to zero)

$$4z_1[(z_2^2 - z_1)^2 + 9z_1z_3] - 4z_2z_3 - 27z_3^2 = 0, \tag{26}$$

where

$$\left.\begin{aligned}
&z_1 = 4a_0a_4 - a_1a_3,\ z_2 = a_0a_4 + a_2a_4 - a_1a_3,\\
&a_0 = \psi[1 - k^2\psi - (2 + \psi k^2)\beta^2],\\
&a_1 = \beta[4\psi(2k - 1) - 2(k^{-1} + \psi)(1 - \beta^2)],\\
&a_2 = a_0 + a_4 + 8(1 - k)(k^{-1} + \psi)\beta^2 - 4(\psi - 1)[(1 - k^{-1} - \beta^2],\\
&a_3 = a_1 + 8\beta(\psi - 1)(1 - k) + 4\beta(k^{-1} + \psi)[(1 - k) - \beta^2],\\
&a_4 = (3 - 2k - \psi)(2k - 1),\\
&\psi = [2\sqrt{\beta^2 + (1 - k)^2} + 2 - 2k - \beta^2k^{-1}](\beta^2 + 1)^{-1},\\
&\operatorname{tg}(v - \varphi) = \beta(1 - k)^{-1},\quad \beta = \operatorname{ctg}\Phi,
\end{aligned}\right| \tag{27}$$

$$e\sin v = \beta(k^{-1} + \psi) \quad , \quad e\cos v = \psi - 1. \tag{28}$$

Here equation (26) with the relations (27) determines the implicit dependence between the parameters ψ and k, which in turn are related to the main variables e, Ψ by means of expressions (28).

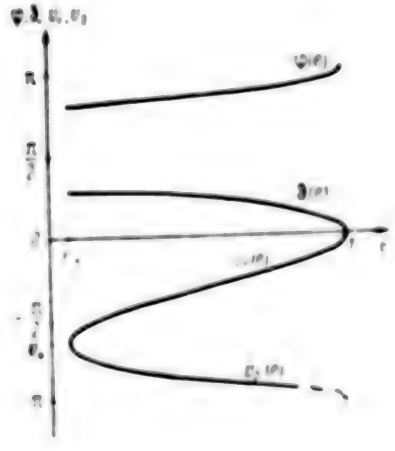

Fig. 1. Curves of the functions $\psi(e)$, $\Psi(e)$, $v_1(e)$, $v_2(e)$.

Thus, the computations revealed that the γ angle is different from 0 and from π; therefore, the tangency of the simplex S and the cone K can occur only at a single point of the simplex S. Hence we draw the following conclusions.

In the problem of finding the minimum fuel flight orbit between close Keplerian orbits the point y_0 corresponding to the initial orbit falls in the set $Q_+ \cup Q_-$, that is, "within" the cone K. The sets Q_+, Q_- are convex and these boundaries contain no segments not falling on the generatrices of the cone K. The non-zero main curvature of the cone K increases without limit with approach to the cone peak y_c. Therefore, here with adequately close limiting orbits, it follows from the condition $\gamma = 0$, $\gamma = \pi$ that the initial contact of the set V with the cone K with a gradual increase in the characteristic velocity from zero can occur only at points falling in the set of velocities in system (1) itself. Each such point corresponds to an optimum one-impulse maneuver. Thus, only one-impulse flights are optimum in the coplanar problem of organizing minimum fuel flight between close Keplerian orbits for all eccentricity values $e \in [0, 1)$.

Now we will turn to the coplanar problem of a minimum fuel maneuver for eliminating intersection of orbits. Here the point $y_0 \in \operatorname{Int} D$, that is, is found "outside" the cone K. With $e > e_*$ the condition $\gamma = 0$, $\gamma = \pi$ and the convexity of the sets Q_+, Q_- ensures the existence of such a position of the point y_0 in the set Int D and such a characteristic velocity u that the set V corresponding to it will be in contact with the cone K at an internal point of the simplex S in such a way that the set of velocities in general will not intersect with the cone K. In such a situation a two-impulse maneuver is optimum. Thus, in the minimum fuel maneuver for eliminating the intersection of close Kepler orbits for $e \leq e_*$ it is only one-impulse maneuvers which are optimum, whereas there are optimum two-impulse maneuvers for any eccentricity value $e \in (e_*, 1)$.

In conclusion the authors express appreciation to V. A. Antonov, doctor of physical and mathematical sciences, for a number of valuable comments.

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5303
CSO: 1866/61

UDC 629.78

COMPUTING ORIENTATION ACCURACY ON BASIS OF PRELIMINARY AXIS DESIGNATION

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86
(manuscript received 22 Apr 85) pp 282-288

[Article by A.A. Chernov and V.D. Yastrebov]

[Abstract] In solution of many problems in spaceflight dynamics there is need for orientation using predesignation of an axis of rendezvous system apparatus, some scientific instrument or some axis of the spacecraft itself on another spacecraft target. A method is proposed for evaluating the accuracy in orientation of the pointed axis and for determining the probabilistic characteristics of the pointing error. The laws of distribution of errors in constructing the base reference system are considered stipulated. The desired angles of programmed maneuvers are made more precise. The position errors for the point to which the axis is to be oriented are also ascertained more exactly. Use of a plane of reference made it possible to reduce the problem to a two-dimensional case and in this way to find the distribution function for the radial deviation of a random point for the case of a normal distribution on the plane. The case of unequal standard deviations of components of a random two-dimensional vector is considered, instead of the commonly used Rayleigh distribution. Parameters are selected which can be used in calculating the total error and its distribution function can be used in highly accurate determination of the accuracy in pointing the designated axis on the spacecraft target. A knowledge of this distribution function makes it possible to compute the field of view of the pointed apparatus with a stipulated probability taking in the spacecraft target after executing programmed maneuvers. Figures 1; references: 6 Russian.

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SPACE ENGINEERING

UDC 629.191

DETERMINING ORIENTATION OF MANEUVERING SPACE VEHICLE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 24 No 2, Mar-Apr 86 (manuscript received 21 Jan 83) pp 289-297

[Article by Ye.M. Potapenko]

[Abstract] It is proposed that space vehicle orientation relative to an orbital coordinate system be determined using a combination of a sensor of absolute angular velocity and a constructor of the local vertical with the processing of information in a Kalman filter. Since optical sensors of the vertical have a small linearity zone, during space vehicle maneuvering the sensor of the vertical must be mounted in a controllable suspension with two degrees of freedom for continuous orientation of the optical axis on the center of planetary emission. During maneuvering of the vehicle interrelationships arise among all the equations of motion and there is a need for taking into account a number of additional velocity sensor errors not taken into account in a stabilization regime and allowance for the kinematics and errors in suspension of the device for constructing the vertical. Therefore, mathematical models were formulated for the output signals of these two sensors. The models are used in writing space vehicle equations of motion. These reveal that with allowance for the nonideal characteristics of the sensors the projection of the equations of motion of a maneuvering space vehicle onto the orbital system of coordinates results in a splitting of the equations of motion into two subsystems, one of which is independent of the other, used in constructing independent filters. Good accuracy characteristics of the system are confirmed by numerical modeling. Figures 2; references 9: 7 Russian, 2 Western.

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MULTILEVEL AEROSPACE SURVEY OF BALTIC SEA

Moscow PRAVDA in Russian 14 Jul 86 p 3

[Article by V. Shirokov, correspondent (Tallin)]

[Excerpt] Not long ago a whole 'crew' of cosmonauts got together in Tallin. The occasion was a conference of the "Intercosmos" [council's] working group on remote sensing of the Earth. Sigmund Jaehn, Georgi Ivanov, Bertalan Farkas and other participants of international space programs are well-acquainted with Leonid Kizim and Vladimir Solovyev, who during the current mission have worked on two orbiting stations. The cosmonauts in Tallin had high praise for their work. It should be noted that an extension of this [mission's] work is being performed by persons who are not so far off from the land and water, who are conducting observations on the bottom level of the aerospace 'etagere.'

Yak Feliksovich Lokk talked about flights over the sea in a helicopter. Results of remote sensing, which is a task of his group in the Baltic Sea department of the Estonian Academy of Sciences' Institute of Thermophysics and Electrophysics, are reflected in photographs, spectral analyses, charts, graphs and figures.

In what way is the Baltic Sea an object of their studies? The study of it is carried out on three levels: from spacecraft, from airplanes and helicopters, and on the water's surface.

The Estonian remote sensing group cooperates closely with the Leningrad Branch of the State Oceanographic Institute, which has assumed a large part of the research in the infrared range of the spectrum. Lokk and his colleagues interpret video information. As a result, they jointly carry out basic aerospace surveying of the Baltic Sea. There is also a growing partnership with the Ukrainian Academy of Sciences' Marine Hydrophysics Institute, which possesses a wealth of experience in studying the Black Sea, using radiophysical methods. Obtaining pictures in different spectral ranges from space, from helicopters and airplanes, and at the water surface by the contact method, they are able to determine according to color and contrast of the pictures which layer of water is being viewed and what substances it contains.

For many users, it is important to know the quality of the water. On the basis of hues and shades, which depend on substances dissolved in the water, the Estonian scientists are able to track the spreading of these substances in the sea, as well as their dilution and mixing. It is possible to determine how harmful substances spread and where. In sum, results of long-distance sensing can be utilized in many different branches of the economy.

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SPACE APPLICATIONS

UPGRADING OF COSPAS-SARSAT SYSTEM

Moscow VOZDUSHNYY TRANSPORT in Russian 20 May 86 p 4

[Article by A. Selivanov, technical director of the Soviet section of the COSPAS-SARSAT project]

[Abstract] The author comments on current and prospective technology of the international satellite-aided search and rescue system COSPAS-SARSAT.

At present the space technology of COSPAS-SARSAT reportedly consists of three Soviet satellites of the "Cosmos" series, and a U.S. satellite, "NOAA." The author says 1986 is considered a pivotal year for the system. The system is supposed to advance from the stage of demonstration and evaluation to the stage of active operation. Problems of transferring surface equipment of the system from 121.5 megahertz to a new operating frequency of 406 megahertz must be solved in this connection. The use of this frequency will eliminate much atmospheric and artificial interference. The author says the equipping of ships and aircraft with transmitter buoys operating on 406 MHz will permit the ownership of the ship or airplane in distress and the type of accident to be identified, and the location to be determined as closely as 2 kilometers. Buoys with a frequency of 406 MHz are expected to go into industrial production this year.

The author mentions in conclusion that the Soviet part of COSPAS-SARSAT is to be featured in the world exhibition EXPO-86 in Vancouver, Canada. A scientific symposium on results of the system's operation was to be held in May of this year, in conjunction with the exhibition.

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SPACE APPLICATIONS

INMARSAT COMMUNICATION CENTER OPENS IN NAKHODKA

Moscow VODNYY TRANSPORT in Russian 26 Jun 86 p 1

[Article by N. Filippetskiy (Nakhodka)]

[Text] The second INMARSAT International Marine Satellite Communications Center in our country has gone into commercial operation in the port city of Nakhodka. International ship-to-shore communication through satellites is now being provided by more than 10 such centers, including two in the USSR--in Odessa and Nakhodka. Connections with shore installations that are many thousands of nautical miles away can be made in minutes with electronic switchboards on ships.

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INSTRUMENT FOR AEROSOL STUDY FROM 'SALYUT-7'

Baku BAKINSKIY RABOCHIY in Russian 27 Aug 86 p 4

[Article by K. Zakharov, (Tartu, Estonian SSR)]

[Text] Photography from outer space has provided pictures of yet another 'actor' with a role in influencing the weather, but which had previously remained 'behind the scenes.' This is aerosol--tiny particles of various substances located in the so-called middle atmosphere.

"Most people think that the weather depends on clouds and the wind," said T.Viyk, director of the Estonian Academy of Sciences' Institute of Astrophysics and Atmospheric Physics. "But these are only signs of local climatic processes. Global changes in weather depend to a large extent on the aerosol. Extraordinarily mobile, it migrates very quickly, presenting meteorologists sometimes with almost unsolvable puzzles. To solve them, our institute developed a series of instruments. They make it possible to locate and to study aerosol, to determine its place and significance in the structure of the planet's atmosphere. One of these instruments was used in taking pictures from the manned orbiting station 'Salyut-7'. The institute's computer center is now busy processing the information."

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UDC 551.593.1

STATISTICAL MEAN VARIATIONS OF ANGLES OF REFRACTION IN ORBITING ASTRONOMICAL OBSERVATORY STUDIES OF TERRESTRIAL ATMOSPHERE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 22 No 5, May 86 (manuscript received 12 Mar 85) pp 546-548

[Article by M.Ye. Gorbunov, Institute of Atmospheric Physics, USSR Academy of Sciences]

[Abstract] Measurements of atmospheric refraction can be used for the reconstruction of meteorological parameters. In this connection there arises the question of the required accuracy of these measurements. Results are given of a numerical determination of the statistical mean variations in the angle of refraction caused by variations in meteorological parameters. A receiver is located at a certain point, A, above the surface of the earth outside the atmosphere. The source is assumed to be infinitely remote. Computations were made of the angle of refraction, ξ, for beams from the source passing through the regions for which computations were made in an earlier study (1980) of correlation matrices of variations in geopotential and temperature. The dependence of the refractive index on humidity was not taken into account, nor were dispersion effects. Numerical calculations were made on a computer of the variance in the angle of refraction, $\langle \xi^2 \rangle$. The standard deviations of the angle of refraction and of the relative Doppler shift corresponding to them were computed for various weather stations over which the beams passed. Relative Doppler shifts were computed on the assumption that the receiver moves in a circular orbit at a speed of 8 km/s. Results are presented for July and January at weather stations in Khabarovsk, Alma-Ata and Yakutsk. Computations performed were accurate to values of the second order of an infinitesimal on the condition that variations in geopotential and temperature are assumed to be values of the first order of an infinitesimal. The accuracy of computations equaled about 5 percent. The results obtained can serve as a basis for estimating the required accuracy of initial data in solving the inverse problem of atmospheric refraction for the purpose of reconstructing meteorological parameters of the terrestrial atmosphere. Figures 2; references 6: 5 Russian, 1 Western.

[121-8831]

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UDC 551.32:528.71(51)

USE OF SPACE SURVEY MATERIALS IN STUDYING MASS EXCHANGE IN GLACIER SYSTEMS

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 5, May 86 pp 26-31

[Article by G.A. Nosenko]

[Abstract] Specialists at the State Scientific Research and Production Center "Priroda" have studied the possibilities of using existing space photographs in determining mass exchange of glaciers using materials obtained during the years 1978-1983 from the "Salyut-6" and "Salyut-7" orbital stations and photographs from "Cosmos" satellites. The Pamir Range was used as a test range and reference region because of the diversity of glacial forms existing there, the adequacy of its study and the possibility of implementing sychronous ground experiments. Surveys of several types can be used in interpreting the snow and firn boundaries on glaciers. Black-and-white films (600-700 nm) of several types are most effective for this purpose; color and spectrozonal films are also suitable. In calculating mean long-term accumulation, precipitation and glacial flow it is best to use data on the elevation of the firn boundary. Differences in image structure of the snow and firn boundaries on space photographs make it possible to interpret them separately. It is sufficient to discriminate this boundary on one or two glaciers in a particular region. It is necessary to use photographs taken at the end of the ablation period for interpreting the firn boundary. Small-scale space photographs can be used with an accuracy adequate for calculations of mass exchange; they have high resolution and extensive coverage. In certain cases, photographs taken during the entire warm period can be used. Such materials and calculations have been used in plotting glacier regime and morphology. A block diagram of the use of space photographs for study of mass exchange of glacier systems is given. Figures 1; references: 5 Russian.

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CSO: 1866/111

UDC 528.77:551.4

AUTOMATED CARTOGRAPHIC PROCESSING OF RESULTS OF SPACE SCANNER IMAGES (AS EXEMPLIFIED BY LINEAMENT NETWORK)

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 5: GEOGRAFIYA in Russian
No 3, May-Jun 86 (manuscript received 2 Oct 85) pp 35-40

[Article by B.A. Novakovskiy, Yu.V. Sventek and A.V. Chernyshev, Moscow State University]

[Abstract] Although the method for interpreting lineaments from scanner images is well developed, problems arise in plotting the interpreted information on maps. This is due to subjective errors which arise due to the high degree of distortion on scanner images and the selection of map projection type, the problem being aggravated the larger the area covered (such as the entire USSR) when using a conic projection. A method is proposed for solving this problem. This involved formulation of an adequate mathematical scheme for the analytical rectification of scanner images into a map projection. This involved constructing an approximating surface for which the difference in the coordinates of the control points on the map and on the scanner image was commensurable with the graphic accuracy of the map. In addition, a system was developed for automated representation of elements of the cartographic base and the rectified image of lineaments matched with it. The described procedures are based on rigorous analytical-photogrammetric techniques with simultaneous analytical correction of geometric distortions. The programming of the steps involved is outlined. The favorable result is illustrated using scanner images obtained from the "Meteor-30" satellite transferred to a map at 1:2,500,000 constructed in a normal equidistant projection. Although devised for proper representation of the lineament network, the method is applicable for distortion-free depicting of other landscape or geomorphological features. Figures 1; references: 4 Russian.

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UDC 528.77:551.4(477+478.9)

USE OF SPACE PHOTOGRAPHS IN STRUCTURAL-GEOMORPHOLOGICAL STUDY OF PLAINS AREAS (EXEMPLIFIED BY SOUTHWESTERN UKRAINE AND CENTRAL MOLDAVIA)

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 5: GEOGRAFIYA in Russian
No 3, May-Jun 86 (manuscript received 30 Oct 84) pp 40-46

[Article by Ye.A. Rubina, N.N. Talskaya and A.V. Chernov, Moscow State University]

[Abstract] Space photographs can be exceptionally effective in a study of plains areas. A visual interpretation was made of multizonal scanner photographs obtained with the "Fragment" system from the "Meteor-30" satellite on 4 July 1981. Using these photographs it was easy to interpret the geomorphological surface features, especially the erosional network, vegetation and economic use of the area. For geomorphological purposes the most informative photographs were those obtained in the near-IR (λ = 0.8-1.1 μm) since the erosional network and morphological features stand out with the greatest contrast; vegetation and landscapes are more readily interpreted on photographs taken in the red zone (λ = 0.7-0.8 μm). Those details which directly or indirectly emphasize the geological and geomorphological surface features are also easily interpreted in the near-IR. The interpreted images were used in compiling a map of block morphostructures in the Southwestern Ukraine and in Central Moldavia (the map is reproduced with the text). The boundaries of the defined morphostructures are faults of different orders which were interpreted primarily on the basis of structure of the erosional network. This experience shows that geomorphological research on plains could profit from surveys at greater scales, particularly for study of fluvial processes which determine the geomorphological appearance of most plains areas. Figures 1; references: 4 Russian.

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UDC 550.814:629:78

EVALUATION OF GEOLOGICAL INFORMATIVENESS OF SPACE DATA FOR PURPOSES OF LARGE-SCALE MAPPING OF NORTHERN PART OF BUREINSKIY MASSIF

Novosibirsk TIKHOOKEANSKAYA GEOLOGIYA in Russian No 2, May-Jun 86 (manuscript received 9 Sep 85) pp 116-118

[Article by M.V. Sukhin, DVIMS [Far Eastern Institute of Mineral Raw Materials], Khabarovsk]

[Abstract] Data are presented which were obtained in the decoding and geological-geophysical interpretation of space photography data on the ore region in the northern half of the Bureinskiy massif. This region has poor out-cropping and a widespread heavy cover of loose deposits, but nevertheless it proved to be possible to obtain additional specific information by using a set of various-scale and various-aspect space photographs to construct a large-scale geological outline. The data obtained consisted of scanning photographs taken from the Meteor-Priroda artificial earth satellite on a scale of 1 : 9,000,000 and 1 : 2,500,000, and ERTS-1-series scanning space photographs on a scale of 1 : 1,000,000, as well as space photographs and space photomaps for regional and local levels, and high-altitude aerial photographs. Special attention was paid to isolating specific linear and ring structures appearing only on space photographs. All available medium- and large-scale geological and geophysical data were used for the purpose of giving a geomorphological, geophysical and geological interpretation of decoded data. The informativeness of the space data was evaluated in terms of the amount of fundamentally new information obtained or the increase in ordinary geological information as compared with the traditional method based on the decoding of aerial photographs. It was found that the decoding of various types of space data on various scales provides additional information and helps to refine the structural gauging of fissure intrusions and vulcanite fields and to trace the outlines of hidden intrusive bodies, to refine and correct the mapped network of discontinuous ruptures, and to reveal deep-lying rectilinear structures and systems of arc-type and ring structures of various types and origin. Relatively ancient faults are usually not isolated on space photographs, but recent faults corresponding to stretching and increased permeability of the earth's crust which serve as channels for the circulation of fluids are most well pronounced on them. A full set of space photographs of various scales should be used for geological photography and prospecting studies. Otherwise, going from large scales to small scales or from aerial photographs to space photographs results in a loss of detail, rearrangement of the pattern of images, and the replacement of some structures and textures by others. Figures 1; references: 7 Russian.

[119-8831]

/8309

UDC 243.3:553.98:629.78(470.56)

GEOMORPHOLOGICAL EXPRESSION OF LOCAL PETROLEUM AND GAS STRUCTURES IN ORENBURG OBLAST ON SPACE PHOTOGRAPHS

Moscow ISSLEDOVANIYA ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 86 (manuscript received 3 May 85) pp 32-38

[Article by N.N. Yakhimovich, Southern Ural Division, All-Union Scientific Research Geological Prospecting Petroleum Institute, Orenburg]

[Abstract] Characteristics of morphological elements on the earth's surface over known petroleum and gas deposits make it possible to detect and predict local structures from space photographs. The study involved 270 petroleum and gas deposits in the Paleozoic sedimentary mantle of the southeastern Russian Platform. Photographs at 1:1,000,000 (or enlarged to this scale) were used. The figures discerned on these photographs are for the most part governed by the hydrographic network. In the study emphasis was on the analysis and classification of the morphological elements, their structural characteristics and degree of expression over deposits and beyond their limits. Three groups of formations could be differentiated: large morphological elements exceeding the area of the deposit, with a diameter of 8-15 km and a length of 20-30 km; small forms associated with them measuring 3-7 km, close in size to individual deposits or occupying part of their area; sharply defined annular and circular-triangular forms with a zonal structure and maximum diameters 30-60 km. Six types of surfaces could be distinguished, differing in photoimage pattern: relatively level, streaked with thin lines, with a ribbonlike division of sectors; ribbonlike surface with distinct transverse dissection; smooth or infrequently streaked surfaces; fine-streaked or smooth surfaces alternating with banded surfaces of dissected relief; surfaces of dissected relief with a great number of contacting and mutually intersecting forms of the type of "nuclei" of annular structures; surfaces with a zonal structure within large well-defined annular forms. Local structural uplifts are manifested as geomorphological anomalies. Examples of petroleum and gas deposits are cited which are directly reflected in isometric forms on the photographs and areas are defined which are most promising for petroleum and gas exploration. Figures 2; references: 5 Russian.

5303/8309
CSO: 1866/105

UDC 551.4:629.78(575.3)

INTERPRETING GENESIS OF SOME ANNULAR RELIEF FORMS (IN EXAMPLE OF GISSARO-ALAY)

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 86
(manuscript received 10 Apr 85) pp 39-40

[Article by A.I. Lavrusevich, State Scientific Research and Production Center "Priroda"]

[Abstract] A circular configuration is one of the most important criteria in assigning features on space photographs to the category of annular structures. On such photographs annular structures are interpreted by the tone of the photoimage against the background or concentric zonality. But in many cases they cannot be discriminated by tone and structural pattern and are identified solely on the basis of the circular form of hydrographic and orographic landscape elements outlining them. Experience has now shown that in the Gissaro-Alay region these annular structures are usually large tectonic blocks bounded by differently oriented faults, through natural processes assuming the annular configuration seen from space. The decisive factor is a network of faults which intersect and have become softened by erosional smoothing. However, other annular formations are associated almost exclusively with the hydrographic network, without relation to the tectonic structure of the substrate on which they develop. Such annular valleys, with a radius of 1 to 8 km, are observed in the high mountains in the nival zone on slopes with a southern exposure and are attributable to glacial exaration processes. Accordingly, these annular or ring structures, which might be attributed to other factors, have an easily interpreted genesis. Figures 1; references: 5 Russian.

5303/8309
CSO: 1866/105

UDC 551.244:553.98:528.77+629.78(571.1)

GEOLOGICAL INDICATORS IN INTERPRETING AEROSPACE PHOTOGRAPHS IN PETROLEUM AND GAS EXPLORATION WORK IN LATITUDINAL REACH OF OB RIVER AND IN ADJACENT AREAS IN WESTERN SIBERIA

Moscow ISSLEDOVANIYA ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 86 (manuscript received 27 Mar 85) pp 41-49

[Article by B.M. Gushchin, Kiev Section, Institute of Geology and Exploitation of Fossil Fuels]

[Abstract] In the exceedingly level and generally swampy areas of Western Siberia the clearest indicator of most recent deformations is the vegetation cover, the types of forest and swamp vegetation, making it possible to draw definite conclusions concerning the geological structure of deep horizons. The validity of this thesis was checked using aerospace photographs covering the area occupied by the latitudinal reach of the Ob River. The following types of photographs were analyzed: black-and-white summer photographs at 1:25,000; multizonal (MKF-6 camera) unsynthesized summer aerial photographs at 1:50,000; black-and-white summer aerial photographs at 1:50,000; large-scale black-and-white summer space and aerial photographs at 1:100,000; medium-scale multizonal summer space photographs; television photographs from "Meteor" artificial earth satellite, winter season, at 1:2,500,000. Each of these is evaluated with respect to information content. The objective was to find what type of photographs and combinations of photographs are most suitable for the detection of local tectonic structures favorable for the formation of petroleum and gas deposits. The selected photographs make it possible to interpret virtually all areal features containing information on the degree of relative drainage, making it possible to detect local structures, including those of minimum extent. Figures 2; references: 4 Russian.

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CSO: 1866/105

UDC 551.465.78:541.65

REMOTE MONITORING OF CONTENT OF SUSPENDED MATTER IN OLIGOTROPHIC AND EUTROPHIC WATER BODIES USING SPECTRAL BRIGHTNESS COEFFICIENT

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 86 (manuscript received 3 May 85) pp 77-83

[Article by S.L. Oshchepkov and L.A. Shlyakhova, Hydrochemical Institute, Rostov-na-Donu; Physics Institute, Belorussian Academy of Sciences, Minsk]

[Abstract] Conclusions are drawn on the basis of combined experiments and a theoretical model of quantitative interpretation of experimental spectral brightness coefficients as a method for determining the content of suspended matter for oligotrophic and eutrophic water bodies in the example of Lake Baykal and the Kakhovskoye Reservoir. The spectral brightness coefficient for the water layer above the surface was computed after subtracting Fresnel reflection of sky brightness at the zenith. Measurements in the wavelength range 440-720 nm were made from a scientific research ship using a "Vertikal" spectrometer. The optimum survey conditions under which the SBC is invariant relative to the influence of external geophysical factors are: solar zenith distance 33-55°, waves not greater than class 2, cloud cover up to 3/10 and angle for sighting water surface brightness ~0°. Spectrometric measurements were made at a distance 3-4 m from the water surface and 1.5 m from the ship's side. Optical measurements were accompanied by taking of water samples with subsequent determination of the concentration of suspended matter, as well as the chlorophyll content. A theoretical study was also made using the known relationship between hydrooptical characteristics and the microstructural parameters of suspended particles. Simulations based on the microstructure of suspended particles are in good agreement with relevant empirical regression equations. An algorithm was formulated for application of the method. Testing of the method revealed its effectiveness in remote sounding of inland water bodies. Figures 3; references: 17 Russian.

5303/8309
CSO: 1866/105

UDC 528.813

ALLOWANCE FOR MULTIPLE SCATTERING IN REMOTE SENSING OF EARTH'S SURFACE

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 86 (manuscript received 28 Apr 84, after revision 13 Jun 85) pp 84-91

[Article by S.Kh. Keevallik and A.G. Kheynlo, Astrophysics and Atmospheric Physics Institute, Estonian Academy of Sciences, Tartu]

[Abstract] An effort was made to exclude the distorting influence of the atmosphere during remote sensing of the earth's surface in the short-wave part of the spectrum. Since real atmospheric parameters are only known approximately, there is no need for precise methods for computing the atmospheric transfer function. A simple but quite precise scheme for taking multiple scattering into account is proposed. This is not a universal method for approximate solution of the transfer equation because its use is limited by real conditions (optical thickness, shape of the scattering indicatrix, sighting geometry) to the cloudless earth's atmosphere. The components of the intensity of ascending radiation are calculated, followed by an analysis of the influence of variations of atmospheric parameters on determination of brightness coefficients of the earth's surface. In all cases the relative error of the brightness coefficient of the underlying surface is proportional to the relative error of the atmospheric parameter (optical thickness), multiplied by a value characterizing the brightness of atmospheric haze. The method is based on an evaluation of the intensity and fluxes of multiple scattered radiation escaping from the earth's atmosphere on the basis of precise information on single scattering. The accuracy is entirely adequate and does not require additional computation time in comparison with the single scattering approximation. References 8: 5 Russian, 3 Western.

5303/8309
CSO: 1866/105

UDC 528.72:681.3

AUTOMATED CLASSIFICATION OF AGRICULTURAL LAND USING MATERIALS FROM SCANNER AERIAL SURVEY

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 86 (manuscript received 17 Jul 84) pp 96-102

[Article by P.Yu. Nagiyev, K.K. Guseynov, E.M. Dzhafarov, R.F. Mamedov, J. Kolarz, B. Kriz, L. Vaneckova and L. Planka, Space Research Scientific Production Association, Azerbaijan Academy of Sciences, Baku; Geography Institute, Czechoslovakian Academy of Sciences, Brno; Czech Polytechnic Institute, Prague]

[Abstract] The results of an automated classification of agricultural lands in a test range in the Czech-Moravian Highlands are presented on the basis of a subsatellite experiment in June-July 1982. An An-30 aircraft laboratory carrying instrumentation having four spectral channels in the range 450-1080 nm was used in a scanner survey. The flight altitude was 6,400 m and the scanner photographs had a scale of about 1:50,000. The dynamic range of the registered brightnesses was 256 gradations. The studied sector included 58 fields which were classified into 15 types on the basis of an analysis of their spectral characteristics. The mean values and standard deviations of the spectral brightnesses of features in all scanner channels were computed. The spectral characteristics of the studied objects differed considerably from one another due to the biochemical composition and volume of crop biomass. The spectral parameters of the objects increase with transition from channel to channel in the range 450-650 nm. In the red zone of the spectrum (650 nm) there is a dip in the spectral curves for all crops. In the near-IR the spectral curves of the crops increase or decrease as a function of the content of chlorophyll and other pigments and the biological characteristics of the studied crops. The spectral characteristics of wheat, barley and rye mutually overlap in all spectral channels, attributable to the closeness of their biometric indices, and accordingly were put into the single category of grain crops. Similarly, it was necessary to use the category "perennial fodder crops" and the general "coniferous" and "mixed" forest categories. An algorithm was formulated for such classification and its application is described. A total of 70 percent of the objects were identified well, 21.5 percent satisfactorily and only 8.5 percent unsatisfactorily. Figures 2; references: 4 Russian.

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CSO: 1866/105

UDC 528.7:629.78

COLOR CODING AS METHOD OF IMAGE PREPARATION FOR THEMATIC INTERPRETATION

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 86 (manuscript received 27 Aug 84) pp 103-109

[Article by L.P. Yaroslavskiy and V.Ye. Gendler, Information Transmission Problems Institute, USSR Academy of Sciences, Moscow; "Aerogeologiya" Geological Production Association, Moscow]

[Abstract] An experiment was carried out with application of the color coding method for visualizing preliminarily processed photographs of the earth's surface using the so-called "moving equalization method" outlined by L.P. Yaroslavskiy in VVEDENIYE V TSIFROVUYU OBRABOTKU IZOBRAZHENIY (Introduction to Digital Processing of Images), Moscow, Sov. radio, 1979. The study was made using a sector of a space photograph taken with the MKF-6 camera from the "Soyuz-22." An automated image processing system with a display processor was used, making it possible to reproduce color images measuring 512 x 256 resolution elements and transferring 256 signal gradations in all three color-separation channels. The objective was to clarify the possibilities of enhancing observation conditions and improving interpretation reliability in geological research. It is shown in an example that use of a color-coded image is more efficient than study of its individual components obtained when using the mentioned equalization method. Less time expenditure is involved, a greater volume of data is obtained for use in geological interpretation and the reliability of this interpretation is better. In a study of the color-coded image it is possible to discriminate all the data obtained in the interpretation of the initial image and the preliminarily processed image, but also, due to color contrasts, to make out additional features of the geological structure. Use of a color display makes possible routine changing of the color coding method for each particular combination, achieving the best visual effect. The color coding variants most favorable for interpretation are those in which the color image tonality is close to the natural coloring of features, but this is not mandatory. Figures 3; references 4: 3 Russian, 1 Western.

5303/8309
CSO: 1866/105

UDC 528.727:581.55

AUTOMATED ANALYSIS OF LARCH PLANTINGS DAMAGED BY INSECTS USING SPECTROZONAL PHOTOGRAPHS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, Mar-Apr 86 (manuscript received 30 Jun 85) pp 110-118

[Article by G.I. Peretyagin, V.I. Kharuk and A.I. Mashanov, Forestry and Timber Institute imeni V.N. Sukachev, Siberian Department, USSR Academy of Sciences, Krasnoyarsk; Automation and Electrometry Institute, Siberian Department, USSR Academy of Sciences, Novosibirsk]

[Abstract] A method for the automated interpretation of spectrozonal photographs for ascertaining damage inflicted on forest plantings by insects is described. The study was based on spectrozonal images of larch forests damaged by the Siberian moth Dendrolimus Sibiricus Tschetv. The aerial survey was made in mid-June in the eruptive phase of mass reproduction of this pest (SN-6M film, scale 1:10,000). Survey data were first interpreted by visual-instrumental methods. The degree of damage was evaluated from the percent of defoliation in a particular sector. Among the interpretation criteria used were penetrability of the canopy, nature of the cast shadow and color differences. A survey at 1:10,000 makes it possible to discriminate stands defoliated 10-20 percent or more. Maps were prepared in three gradations of defoliation (10-30, 30-70 and 70-100 percent defoliation). Image negatives were used in automated processing. Color negatives were reduced to digital form using a "Colormation" apparatus with filters discriminating optical density levels corresponding to the three principal colors. The analysis procedure is described in detail; the segmentation procedure applied is outlined. Either textural or spectral criteria can be used in interpreting insect damage to larch, but the latter are more informative. Figures 4; references 11: 9 Russian, 2 Western.

5303/8309
CSO: 1866/105

SPACE OFFICIAL ON USSR COMMERCIAL LAUNCH SERVICES WITH PROTON ROCKET

Moscow MOSCOW NEWS in English No 35, 7-14 Sep 86 p 10

[Interview with Dmitriy Poletayev, department head of USSR State Committee for Space: "Proton Rocket for Commercial Launches"]

[Text] **The Soviet Union has offered other countries and international organizations a variety of space services on attractive terms. Mikhail Chernyshov asked department head of the USSR State Committee for Space Dmitry POLETAYEV about this.**

[Question] **Until recently the most typical kind of space services available to other countries was the putting of their satellites into orbit for a certain charge. The service was provided exclusively by the USA and the European Space Agency (ESA). What's the position now?**

[Answer] There is a tendency in many parts of the world to set up national or international satellite systems not only for communication but also for navigation, nature study and other purposes. A number of countries are trying to benefit from space technology in order to produce materials in zero-gravity conditions. This includes such items as semiconductors with unique properties or medicines and valuable biological drugs. Many countries see the great advantages of using space technology to survey and develop natural resources. All this increases the need to put a variety of objects – from a whole space apparatus, to a technological plant to a capsule containing materials to be smelted in weightlessness – into orbit.

The Soviet Union has done much and continues to do much to broaden joint research in these fields under the various international programmes. Today we are prepared to put in orbit payloads of other countries and international organizations on commercial terms that offer our customers certain benefits.

[Question] **Do you mean tariffs or what?**

[Answer] Surely, the cost of putting cargoes in orbit is among the main factors affecting the future of a satellite system. The Soviet Union is in favour of tariffs that are equally advantageous to customers and those who serve them. The Soviet Union proposes, for example, that satellites of the Inmarsat system be put into orbit at a price which is nearly 20 per cent less than the ESA estimated cost of launching the same satellite with the Ariane rocket or with the NASA's space shuttles. This suggests that Inmarsat, an international organization for commercial ship-to-shore communication via space satellites, which today brings together 40 countries, would have considerable financial gains if it accepts the Soviet Union's offer to launch the system's satellites via Soviet Proton rockets.

[Question] **Reliability of carrier rockets has always been a key problem in space technology. Their reliability comes to the fore of late especially if one thinks about the US and European rocket failures to say nothing about the Challenger disaster. What is the Proton's reliability?**

[Answer] A country which loses its space cargo through the launching agency is to be reimbursed by insurance coverage. But the money is not always totally recompense the loss. Normally, before a satellite is launched, ground-control equipment is either purchased or manufactured, personnel trained and some plans made by the country. The loss of communication satellites by India and Indonesia through the US fault had painful repercussions in those countries. Thus reliability of carrier rockets is a matter of special urgency today, and as regards the Proton its reliability factors are higher than all other types of rockets.

I want to be correctly understood. We are not out to prove whose rocket is better, or whose is worse. But reliability is found from corresponding statistics, or specifically, from the correlation of successful and unsuccessful launches when the number of launches was sufficiently large. The latter is essential. Say, there was the first successful launch of a new rocket. But this does not signify the rocket is one hundred per cent reliable.

[Question] **The Proton has been in service for more than two decades. This is one of the more familiar and reputed Soviet rockets. What about its launch statistics?**

[Answer] The appropriate statistics are available on request to any foreign organization or firm. I can also add that the Proton is used in a three-stage version. The rocket is capable of taking payloads of up to 20 tons to low (up to 200 km) orbits around the Earth. Accidentally, it was used to launch all the Soviet space stations in the Salyut series and the Mir station. A four-stage Proton can deliver payloads of 5.7 tons towards the Moon and 5.3 or 4.6 tons towards Venus and Mars correspondingly. Most of the Soviet communication satellites of the Ekran, Gorizont and Raduga series and satellites used by the Intersputnik international space communication organization are put into geostationary orbits around the Earth by four-staged Protons. The Proton was used to launch most of the Soviet interplanetary probes including Vegas to study Venus and Halley's comet. The Proton is capable of putting satellites weighing nearly two tons in geostationary orbits. In practical terms the Proton can lift any payloads existing today. Out of the total of 97 launches since 1970 only 7 were unsuccessful.

[Question] **The emergence of the Proton on the international market some two years ago caused a turbulent reaction from Washington. The US administration tried to put undisguised pressure on the Inmarsat to burn off Proton's competition. The reasons advanced were plainly ridiculous. It was alleged, for example, that since Inmarsat satellites use some American components Soviet experts can open them and get access to classified technology while transporting the satellites to Baikonur cosmodrome...**

[Answer] That allegation is hardly convincing. The Soviet Union stated right from the start and confirms this now that representatives of manufacturing firms, the British Aerospace, for example, can accompany their satellites as they are transported across the USSR and up to the moment the rocket leaves the launching pad. Generally speaking, it's clear to everyone that all talk about classified technology is only a pretext. The real reason is the USA's desire to monopolize the market at any price and under all circumstances. But this is hardly the best way to act in commercial space or in any other sphere for that matter.

[Question] **What are the potentialities of the traditional and new kinds of space services? Are there any specific offers or plans for cooperation on a commercial basis?**

[Answer] This is a new area for us and not everything, of course, depends on the Soviet side. There are already some definite projects while many things are still only being discussed. Let's say that in 1987 the Soviet Union will be launching on a commercial basis the first Indian nature study satellite.

There is a firm commitment on this score. Finland is showing interest in setting up a system of direct television broadcasting. This system will use many components of Soviet space technology. In various stages of discussion are projects for setting up communication systems for Iran and several countries in Latin America.

A completely new area for commercial cooperation is being opened in space technology. We have space plants such as Splav and Zona which have proved to be very helpful in the production of semiconductors. The proportion of usable product manufactured from materials made in space is often dozens of times higher than what can be manufactured on the bases of Earth-bound technology. The Soviet Union welcomes orders for smelting in space using customers' materials and naturally observing all the requisite procedures. Such smelting can be done in automatic mode on board satellites in the Kosmos series.

I would think we could offer our customers acceptable economic terms. Costs do not necessarily have to be paid in money, but in some cases by sharing finished products or technological equipment. We also offer electrophoretic operations – the manufacture of medicines and biological preparations – and other types of operations. As for the future, it offers many more opportunities for the commercial use of space.

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SPACE POLICY AND ADMINISTRATION

JOINT FLIGHT WITH SYRIAN COSMONAUT SET FOR SECOND HALF OF 1987

Damascus SANA in Arabic 1345 GMT 24 Aug 86

[Text] Damascus, 24 Aug (SANA). Syrian astronauts Munir Habib and Muhammad Faris have asserted that the joint spaceflight project between Syria and the USSR crowns the growing relations between the two countries in various fields.

At a news conference held here yesterday, the two Syrian astronauts added that this space cooperation indicates that Syria and the USSR have a joint stand in one trench to confront the dangers posed by the aggressive acts of imperialism and world Zionism.

They pointed out that the date set for the spaceflight will be in the second half of 1987. They said: The first stage of our study has been theoretical during which we learned theoretical sciences and physical exercises. The next stage will be an implementation study during which theoretical sciences will be embodied in preparation for spaceflight.

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CSO: 1866/17

SPACE POLICY AND ADMINISTRATION

FRENCH COSMONAUTS SELECTED FOR 1988 MISSION WITH USSR

Alma-Ata KAZAKHSTANSKAYA PRAVDA in Russian 1 Aug 86 p 3

[Text] France's National Center for Space Research has finished screening candidates for the upcoming joint Soviet-French space mission in 1988. Jean-Loup Chretien, the first French cosmonaut, has been chosen for this mission. In the summer of 1982, he took part as a cosmonaut-researcher in the Soviet-French space flight on board the spaceship "Soyuz T-6."

Jean-Loup Chretien is now working at the National Center. In particular, he is taking part in research connected with development of manned spaceships. Test pilot Michel Tonini, a lieutenant-colonel of the French air force, has been chosen as Chretien's back-up.

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SPACE POLICY AND ADMINISTRATION

CEMA COUNTRIES TO DEVELOP SATELLITE COMMUNICATION EQUIPMENT FOR SHIPPING

Moscow IZVESTIYA in Russian 19 Jul 86 p 2

[Article by A. Knop (Odessa)]

[Text] What kinds of shipboard communications-satellite terminals are needed so that seamen can communicate with shore at any time of day and from any point in the oceans? This question and many more were discussed at a meeting in Odessa of specialists from the Soviet Union, Bulgaria, the GDR and Czechoslovakia.

Radio communication through space is being used more and more in shipping for the solution of routine problems. It is already recognized as a great aid in organizing search and rescue operations.

"Nevertheless, marine satellite-communications equipment has barely gotten its feet wet," said Yu. Lavkovskiy, deputy chairman of the All-Union Association "Morsvyazsputnik" (marine satellite communications). "Therefore specialists of the countries that belong to the Council for Mutual Economic Assistance have decided to pool their efforts in development and production of satellite equipment for shipping. Today satellite communications primarily serves the shipping industry. But in the future, it is reasonable to expect that it will be used by members on far-off expeditions, geologists, and railroad workers. Dozens of seagoing ships now use the services of the space-communications station that was built near Odessa. A second ground center of this type recently went into operation in Nakhodka."

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SPACE POLICY AND ADMINISTRATION

'INTERSPUTNIK' GROUND STATION COMMISSIONED IN NICARAGUA

Moscow KOMMUNIST in Russian 20 Jul 86 p 4

[TASS Report]

[Excerpt] Managua, 18 July--A ground satellite-communications station of the "Intersputnik" system, which was built with technical assistance from the USSR, has been commissioned at a ceremony in a suburb of Nicaragua's capital. Present at the ceremony were Daniel Ortega, president of the republic, and a Soviet delegation headed by V.A. Shamshin, member of the Communist Party of the Soviet Union and USSR minister of communications.

During a tour of the station, Daniel Ortega noted that the Reagan administration has tried to raise a slanderous furor over the construction of a space-communication station in Nicaragua, alleging that the station is a 'secret facility' which 'threatens U.S. security,' contrary to plain facts. Our republic is legitimately entitled to improve its system of international communications, and it is deeply grateful to Soviet specialists, the president of Nicaragua emphasized.

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SPACE POLICY AND ADMINISTRATION

MARSHAL AKHROMEYEV ON POSSIBLE RESPONSES TO SDI

Moscow KRASNAYA ZVEZDA in Russian 26 Aug 86 p 3

[Abstract] The lengthy article reports on a 25 August press conference for Soviet and foreign journalists at the USSR Ministry of Foreign Affairs, to discuss the recent statement of M.S. Gorbachev announcing continuation of the Soviet moratorium on nuclear testing and addressing other questions of arms control. Appearing at the press conference were Yu.M. Vorontsov, USSR first deputy minister of foreign affairs; Marshal of the Soviet Union S.F. Akhromeyev, chief of the General Staff of the Armed Forces and USSR first deputy defense minister; and G.I. Gerasimov, head of the information office of the USSR Ministry of Foreign Affairs.

The article summarizes opening remarks by Vorontsov regarding Gorbachev's statement, and it records a number of the journalists' questions and the three speakers' replies. Following is an excerpt of the answer to a question about what Gorbachev meant in his statement when he said the USSR would find a response to the 'Star Wars' program that would make it worthless:

..."As a military specialist," noted S.F. Akhromeyev, who replied to this question, "I can sayconfidently that the United States does not possess a monopoly on scientific-technical progress in the military field. The advancement of science and technology in the military field has reached such a level that the age-old competition between the 'sword and the shield,' between offensive and defensive weapons, today is decided not in one but in many areas. For every measure, reliable countermeasures may be found.

"To the actions of the United States to disrupt the balance by developing an anti-missile system of defense of the country and space-based strike weapons, the USSR could undertake an identical response. The USSR is able to do this.

"It is possible also to improve strategic offensive weapons to such a degree that it would make the program for an anti-missile defense of the territory of the United States fabulously expensive and extremely difficult to implement.

"Also possible are other responses which would make the 'Star Wars' program worthless. The USSR has been forced to conduct basic research in many directions in the field of defense. Among them are ones which provide assurance of effective measures of counteracting an anti-missile defense of the territory of the United States. These measures, moreover, can be implemented opportunely. If the United States, in spite of this, deploys a multi-level anti-missile system of defense of its country and space-based strike weapons, the USSR will choose those methods which satisfy the interests of its defense to the fullest degree, which in turn will present the United States with the necessity of finding a response to this. Our measures will not be ones which figures in Washington would like to persuade us to take."

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CSO: 1866/16

SPACE POLICY AND ADMINISTRATION

LENINGRAD INSTITUTE AWARDED FOR WORK ON PROJECT 'VEGA'

Leningrad LENINGRADSKAYA PRAVDA in Russian 6 Jul 86 p 1

[Text] Basic research and applied developments of scientists of the Institute of Precision Mechanics and Optics (LITMO) for the project "Venera--Kometa Galleya" have been judged to be among the best scientific works done at higher educational institutions in the past year. The group of researchers who took part in this creative undertaking has been awarded a prize of the USSR Ministry of Higher and Specialized Secondary Education.

"Our group developed an optical-mechanical instrument complex for the television system in collaboration with other institutions and organizations," related Professor G.N. Dulnev, president of the institute. "This complex made it possible to aim instruments at objects in space and to obtain images of [Halley's] comet and its nucleus in various bands of the spectrum. The complex included a wide-angle lens for a television sensor for observations, a reflecting-refracting telescope with a focal distance of 1,200 millimeters and a main mirror 240 millimeters in diameter, and optical-mechanical units that made it possible to take pictures in different bands of the spectrum."

The LITMO associates' participation in the "Vega" project has had an impact both on the heightening of research standards at the institute and on its educational process.

FAD/SNAP
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CSO: 1866/16

SAGDEYEV HONORED FOR PROJECT 'VEGA'

Moscow IZVESTIYA in Russian 9 Sep 86 p 1

[Text] By decree of the presidium of the USSR Supreme Soviet, the title of Hero of Socialist Labor has been conferred upon comrade Roald Zinnurovich Sagdeyev, director of the USSR Academy of Sciences' Institute of Space Research, and he has been awarded the order of Lenin and the gold "Hammer and Sickle" medal for his great contribution to the carrying out of the international project "Venus-Halley's Comet."

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SPACE POLICY AND ADMINISTRATION

PREPARATIONS FOR LAUNCH OF INDIAN RESOURCES SATELLITE

Vilnius SOVETSKAYA LITVA in Russian 16 Sep 86 p 3

[Excerpt] Another working meeting of Soviet and Indian specialists who are taking part in a joint program called "IRSS" was held at the USSR Main Administration for Development and Use of Space Technology for the Economy and Scientific Research on 15 September. This program calls for launching an Indian satellite for remote study of the Earth next year, using a Soviet launch rocket.

"The satellite 'IRSS' will be equipped with two optical-mechanical devices with high resolution, for direct transmission of information to Earth," said U.R. Rao, chairman of the Indian Space Commission. "This information will be used in the interests of various branches of the economy, including geology."

"Work on the 'IRSS' project is proceeding successfully," noted academician A. Bogomolov. "Instruments are being readied, as are the satellite itself and its launch rocket. We specialists of the 'Medvezhi Ozera' center in suburban Moscow are also preparing. The flight will be controlled from this center."

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SPACE FLIGHTS--ACHIEVEMENTS AND PROSPECTS

Riga NAUKA I TEKHNIKA in Russian No 4, Apr 86 pp 8-9

[Article by Yuriy Ivanov]

[Text] In a quarter of a century Soviet cosmonautics has made a journey full of outstanding events. They are the foundation of future achievements which as yet exist only in the ideas of scientists.

After Yuriy Gagarin's flight on the spaceship Vostok, they began to call him the "citizen of the planet." The date of 12 April 1961 became a decisive milestone in science.

Space research today is no longer in the category of exceptional events. The mastery of outer space for peaceful purposes has become systematic, businesslike. Modern Soviet cosmonautics is represented by powerful rockets, satellites, manned vehicles, and automatic interplanetary and orbital stations. It is both superlong-range radio communications, and television, and satellite navigation, as well as the solution of many of science's fundamental problems.

Now we can assess with great comprehension the value of our achievements in space.

As early as four months after Yu. Gagarin's flight, German Titov completed a flight lasting more than 24 hours. A year later, in April 1962, Yuriy Gagarin in speaking before journalists said: "My flight, German Titov's flight and that of the American John Glenn proved that man can not only live in space, but also work there. Now scientists and cosmonauts must determine how long man can work in outer space without damage to his health--five, 10 days, or a longer time."

"Five, 10 days." Leonid Kizim, Vladimir Solovyev and Oleg Atkov--the crew of the third lengthy expedition of the Salyut-7 - Soyuz orbital complex--stood watch in space continuously for 237 days. Some journalist calculated that in their orbital voyage these cosmonauts flew a distance equal to the distance of a flight from the earth to Mars and back.

Each year was celebrated with some kind of new achievement: 1962--the first group flight of Andriyan Nikolayev and Pavel Popovich; 1963--the group flight of Valeriy Bykovskiy and the first female cosmonaut, Valentina Tereshkova; 1964--the flight of Vladimir Komarov, Boris Yegorov and Konstantin Feoktistov in the three-seat Voskhod; 1965--Aleksey Leonov's entrance into open space. All this work was innovative, but at the same time rather simple in the engineering respect. It was precisely this which made it possible to maintain the fast pace of the implementation of new programs.

Experiences necessitated the development of multipurpose vehicles capable of performing quite varied tasks for an extended period. The Soyuz spaceship became such a vehicle. The fact also became ever more obvious that the fundamental mastery by man of circumterrestrial space is possible only with the development of bases operating for a long time--longterm orbital stations. Therefore, in the flights of the Soyuz-4, -5, -6, -7 and -8 the problems were worked out of the maneuvering in orbit, retrieval, rendezvous and docking of space vehicles, and the transfer of cosmonauts from one vehicle to another.

The first orbital stations developed in our country were implemented according to a very simple design--with one docking unit. This simplified the construction of the station itself and its operation. The second-generation stations (Salyut-6 and Salyut-7) had two docking units and were designed for repeated mating with them of manned and automatic vehicles.

In the launching of the first Salyuts, food, fuel and water were collected at once for the entire proposed period of operation of the station, since the opportunities for the replenishment of supplies were not great: Manned vehicles which changed crews were not designed for these purposes. The ability to update on-board scientific equipment was also modest. For this reason, a station was utilized for a considerably shorter time than its stay in orbit. Incidentally, the work of the first American orbital station, Skylab, was also distinguished by this shortcoming. Although it was in orbit for many years, the time it was used in the manned mode equaled a total of 171 days.

The fundamentally new organization of work suggested by Soviet scientists sharply improved the efficiency of orbital engineering. The use of Progress cargo vehicles in addition to manned vehicles was provided in the "Earth-Orbit" transport system. The new system was implemented for the first time on Salyut-6: The station was in flight from 29 September 1977 to 29 July 1982, and the time it was operated in the manned mode equaled almost two years. Flights were completed to the station by 16 Soyuz vehicles, 4 Soyuz-T vehicles and 12 Progress, which delivered 22 tons of various kinds of cargo and equipment (the takeoff weight of Salyut-6 with all its equipment per se equaled about 19 tons). Five principal crews and 11 guest crews, including 8 international, worked at the station. This equaled 27 cosmonauts, 6 of whom stayed on board the complex twice. Seventy large scientific instruments were used on Salyut-6. Instruments and apparatus appeared on board, many of which as of the moment of the station's takeoff were only in the drawing stage and even in the stage of scientists' and designers' ideas. Such was the case with the KRT-10 space radio telescope, for example. The cosmonauts

worked not with obsolete equipment but with the most modern. A total of more than 1600 experiments were performed in astronomy, natural history, technology, medicine and biology.

In the course of the technological experiments on board the station, more than 300 specimens of various materials were produced, in which many branches of industry were interested. In particular, semiconductors were produced which are quite promising for use as detectors of infrared radiation and in tunable laser equipment.

Tens of thousands of photographs in which were captured many times millions of square kilometers of the earth's surface were taken on board Salyut-6. And it must be mentioned that it is possible to photograph an area measuring millions of square kilometers in only 10 minutes from on board an orbital station with the MKF-6M camera. This would take seven years with aerial photographs. Because of photographs from space, geologists, for example, have gained the ability to produce charts which are not only of higher quality, but at a cost of 20- to 30-percent less than when using traditional methods. Space photography already today is producing a saving to the tune of hundreds of millions of rubles a year.

The new Salyut-7 Soviet orbital station took off into space on 19 April 1982. The duration of flights, as we know, gradually grew on Salyut-6: 96, 140, 175 and 185 days. Anatoliy Berezovoy and Valentin Lebedev--the first crew of Salyut-7--immediately overstepped this boundary, by having worked 211 days, or about 7 months, in space.

Then there were flights lasting 150 and 237 days. Four guest expeditions worked on the station (a total of 21 cosmonauts together with the principal crews), including two international ones, with the participation of astronauts from France and India. Svetlana Savitskaya stayed on the station twice, and Vladimir Dzhanibekov three times.

During the station's operation it was also necessary to perform repair and restoration work. It was performed not only inside the station, but also in open space.

Especially great ordeals fell to the lot of Vladimir Dzhanibekov and Viktor Savinykh. Because of a loss of communication with the earth on Salyut-7, important components of the power supply system failed. The lighting and heating systems on board the station did not operate. The cosmonauts managed to mate with an unguided station which did not respond to signals, and for many days worked in the cold without warm food and breathed oxygen-depleted air. Numerous systems of the station were put into operation, and it itself returned to life.

What is the future of orbital stations?

Many directions of cosmonautics, e.g., space technology, astronomy, etc., have already reached such a level of research that one or two new instruments are too little for further advances. A system of apparatus is needed, essentially

special-purpose laboratories, and perhaps even unique production shops. It is practically impossible to accommodate them in a single orbital station, but there is also no need for this. Another alternative is more optimal--the docking at the station of replaceable special-purpose modules. They can be replaced with a change in the research program. The launching of the Mir station became an important step in this direction. It is furnished with a new docking system, six docking units, and it represents the basic module for constructing a multipurpose constantly operating manned complex.

Space technology, which entails the prospect of setting up industrial production in space, has been most prepared for the "modular" mode of working. However, there are still enough problems here. First of all, it is necessary to develop the scientific principles of this kind of production, i.e., find the optimal conditions for the performance of production processes in space.

Another condition is the profitability of a production process. Meanwhile just the delivery of a load into orbit and back turns out to be not inexpensive. Therefore, at the first stage it can only be a question of producing individual kinds of materials the demand for which equals tens or hundreds of kilograms a year. In particular, these include large-dimension semiconductor chips, certain biological specimens and high-quality glasses for lasers. According to today's estimates, the cost of terrestrial production for the majority of these materials is comparable to or even higher than the cost of delivering them into orbit and back. This means that production in space already now can produce a net profit. With time an ever greater number of materials will enter the category of profitable ones (taking into account the rising cost of production on the earth because of the high requirements for materials produced and the lowering of the cost of space transportation). Besides, their quality will be higher in comparison with terrestrial analogues. For example, much less space material is necessary than terrestrial material for producing a certain number of integrated circuits, and the reliability and quality of devices increases sharply.

Orbital complexes will include also astrophysical modules from on board which studies will be made of the sun and stars and distant galaxies, biological modules for developing the principles of the creation of ecologically closed systems, etc. With this, the basis of the prefabricated designs--the orbital modules--will remain for a long time to come broad-profile facilities, where new methods and instruments will come to be developed and several kinds of studies will be conducted. Here cosmonauts will live, work, rest, receive guest expeditions and cargo, and control the operation of modules.

Space operations require the improvement of transport operations: it will be necessary to provide for the growing demand of orbital complexes for energy, replaceable components, scientific instruments and apparatus.

An extensive set of studies in circumterrestrial space will be performed also by means of unmanned vehicles. One of the main objectives here will be an analysis of the cause-and-effect relationships and mechanisms of global processes in the closest vicinity of the earth, which are determined to a considerable extent by solar activity. The studies will be primarily integrated, utilizing several space vehicles at once.

Ever greater attention will be paid to so-called active experiments, when processes and phenomena of interest to scientists are produced artificially, e.g., by the injection of plasma beams or by directed electromagnetic radiation.

Extra-atmospheric studies of the sun from near-earth orbits and interplanetary routes will continue. Their objective is to penetrate more deeply into the essence of the physical phenomena responsible for the flare activity of our star.

The delivery into near-earth orbit of large telescopes, primarily, is considered promising for space astronomy. Advances in observational astrophysics involve improving the sensitivity of instruments and their energy resolution. The most important feature of space instruments in this area, slated for launching in the second half of the 80's, will be the ability to construct images of observed objects over a wide range of energies of the x-ray and gamma-ray bands.

Another promising direction of astrophysical research is the development of large orbital radio telescopes. By their means it will be possible to implement a space radio interferometer with practically unlimited resolution. The experiment with the KRT-10 space radio telescope on the Salyut-6 orbital station became the first important step in this direction. Under way now are the development of improved instruments, the selection of the most optimal observation channels, and a study of the influence of terrestrial interference on them. One important problem is the development of unified design components from which radio telescopes of any size could be assembled in space.

Of course, those near-earth space systems which have already for a long time been of specific benefit to man's economic activity--space communications, meteorology, and geodesy--will be given further development.

The continuation of direct studies by space engineering facilities of other bodies of the solar system is foreseen. As before, Venus and Mars are listed in the plans of Soviet cosmonautics. But comets, asteroids and satellites of planets have already been added to them.

The successful implementation of these plans will not only provide unique information on the origin and evolution of the solar system, but also will determine to a great extent the strategy for the mastery of outer space by man.

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LAUNCH TABLE

LIST OF RECENT SOVIET SPACE LAUNCHES

Moscow TASS in English or Russian various dates

[Summary]

Date	Designation	Orbital Parameters			
		Apogee	Perigee	Period	Inclination
6 Jun 86	Cosmos-1756	368 km	182 km	89.7 min	64.9°
10 Jun 86	Gorizont	36,540 km	--	24 hrs 34 min	1.5°
	(Communications satellite; circular, near-stationary orbit)				
11 Jun 86	Cosmos-1757	252 km	189 km	88.6 min	82.3°
	(For continued research on Earth resources; data goes to "Priroda" Scientific-Research and Production Center for processing & use)				
12 Jun 86	Cosmos-1758	682 km	644 km	97.8 min	82.5°
19 Jun 86	Cosmos-1759	1,016 km	985 km	104.9 min	82.9°
19 Jun 86	Cosmos-1760	421 km	218 km	90.6 min	70°
20 Jun 86	Molniya-3	40,679 km	640 km	12 hrs 16 min	62.9°
	(Communications satellite for long-distance telephone, telegraph & radio communication and broadcast of USSR Central TV to points in the "Orbita" network)				
5 Jul 86	Cosmos-1761	39,325 km	607 km	11 hrs 49 min	63°
10 Jul 86	Cosmos-1762	304 km	196 km	89.2 min	82.6°
	(For continued research on Earth resources; data goes to "Priroda" Scientific-Research and Production Center)				

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DATE FILMED

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